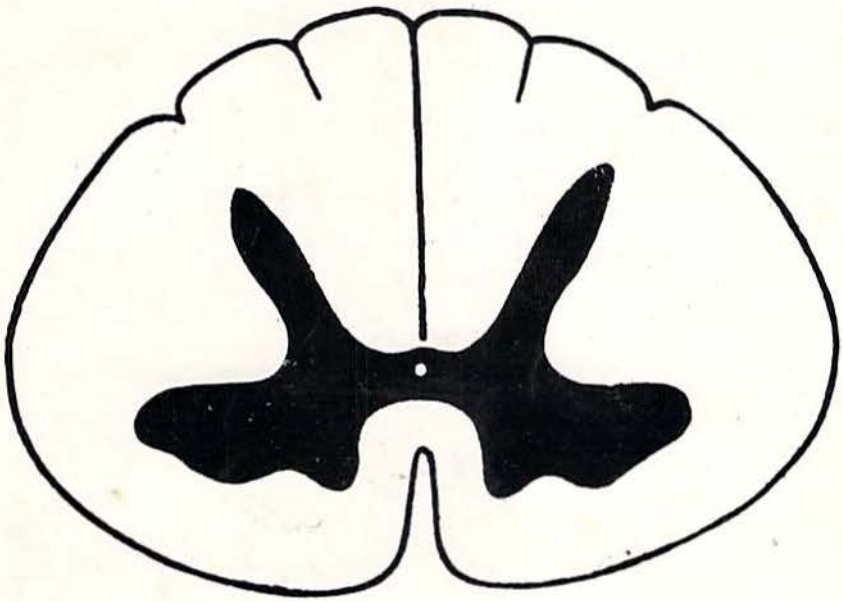
ATLAS OF ANATOMY

NEUROANATOMY



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PREFACE

This " ATLAS OF NEUROANATOMY " contains 404 figures on the gross anatomy and internal structure of the central nervous system. The main anatomical facts are illustrated in a clear way, and the diagrams are provided with concise explanatory notes.

The authors hope that this diagrammatic atlas will be helpful to the medical students as a guide to better understanding of neuroanatomy.

Cairo, 1991

FAWZI GABALLAH

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OTHER BOOKS BY THE SAME AUTHORS

1. Atlas of Anatomy (other parts).
2. Atlas of Embryology.
3. Basic Anatomy (detailed textbook).
4. Neuroanatomy.
5. A Summary of Anatomy (all parts).
6. Oral Questions in Anatomy.
7. Basic Embryology.

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SPINAL CORD

GROSS MORPHOLOGY OF SPINAL CORD

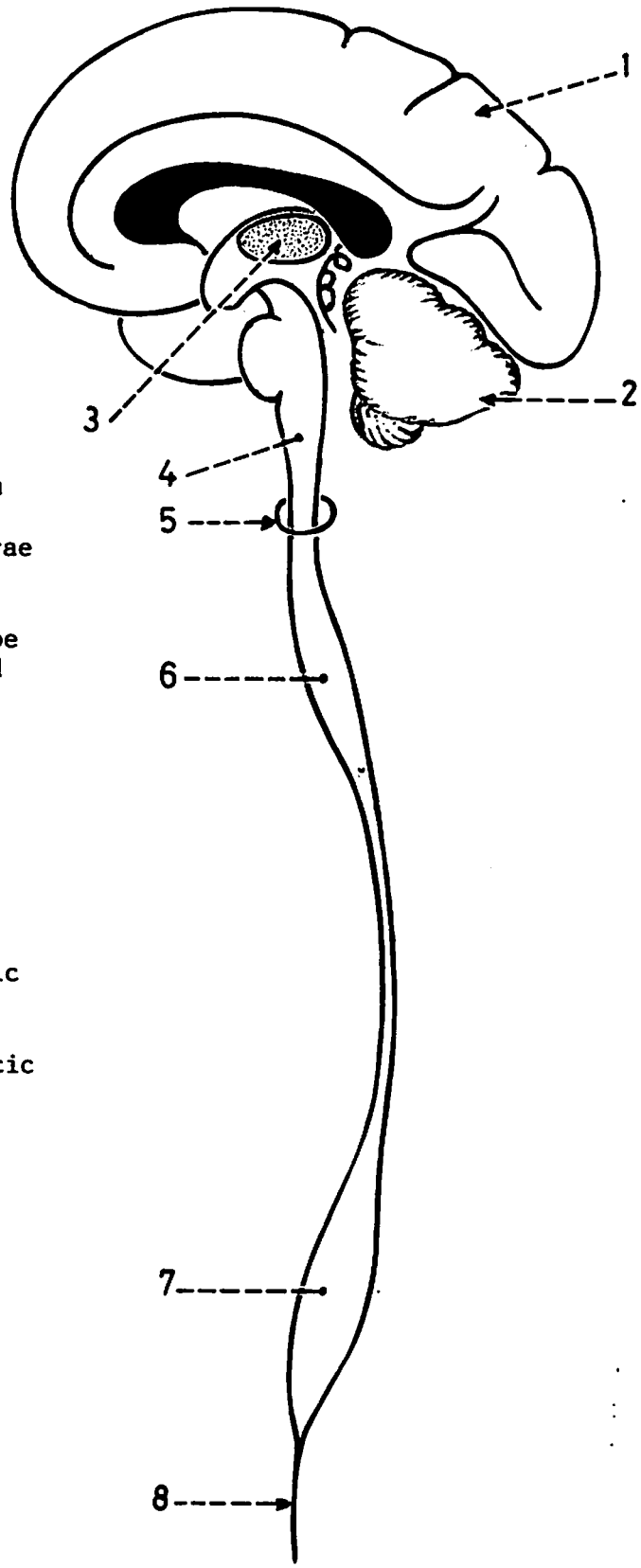


Fig.(1): POSITION AND SHAPE OF SPINAL CORD

The spinal cord lies in the upper 2/3 of the vertebral canal, extending from the foramen magnum down to the disc between the 1st and 2nd lumbar vertebrae It is continuous below in the form of a fibrous cord called filum terminale. The spinal cord is cylindrical in shape and shows 2 enlargements: cervical and lumbar.

1. cerebrum.
2. cerebellum.
3. thalamus.
4. brain stem.
5. foramen magnum (beginning of the spinal cord).
6. cervical enlargement (extends from the 2nd cervical to the 1st thoracic vertebra).
7. lumbar enlargement (extends from the 9th thoracic to the 12th thoracic vertebra).
8. filum terminale.

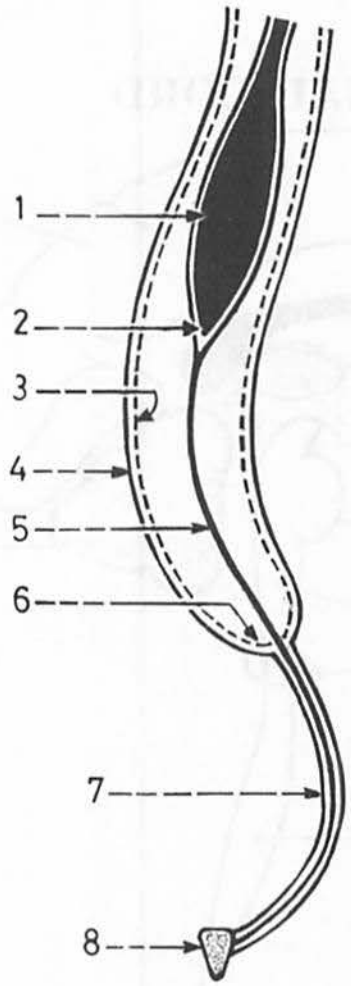


Fig.(2): LOWER END OF SPINAL CORD

The lower end of the cord is conical in shape and called conus medullaris. It is continuous with the filum terminale which extends downwards to get attached to the back of the coccyx.

1. lumbar enlargement.
2. conus medullaris.
3. arachnoid mater.
4. dura mater.
5. filum terminale in the sub-arachnoid space.
6. lower end of the arachnoid tube (opposite the 2nd sacral vertebra).
7. filum terminale in the sacral canal (surrounded by a sheath of dura mater).
8. coccyx.

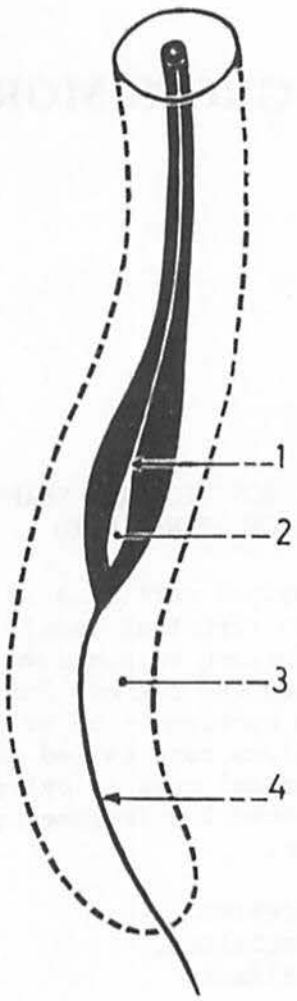


Fig.(3): CENTRAL CANAL OF SPINAL CORD

The central canal extends within the spinal cord and is dilated below in the conus medullaris to form the terminale ventricle.

1. central canal.
2. terminal ventricle (in the conus medullaris).
3. subarachnoid space (filled with cerebrospinal fluid).
4. filum terminale (a fibrous filament formed of pia mater).

Fig.(4): SULCI OF THE SPINAL CORD

These are longitudinal grooves along the whole length of the spinal cord.

1. posterior median sulcus.
2. posterolateral sulcus.
3. central canal.
4. site of emergence of the ventral root of the spinal nerve (faint anterolateral sulcus).
5. anterior median fissure (the deepest).
6. white commissure.
7. anterior horn of grey matter.
8. posterior horn of grey matter.
9. posterior median septum (formed of neuroglia).

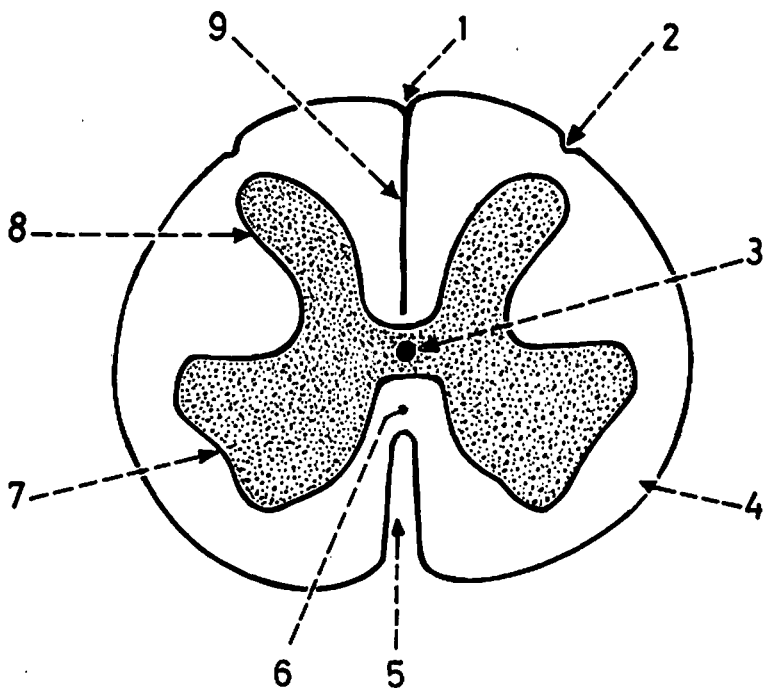


Fig.(5): SPINAL SEGMENT

It is a segment of the spinal cord to which a pair fo spinal nerves are attached.

1. spinal segment.
2. dorsal root of a spinal nerve.
3. dorsal root ganglion.
4. trunk of a spinal nerve.
5. ventral root of a spinal nerve.

* Note that the spinal cord consists of 31 segments corresponding to the 31 spinal nerves.

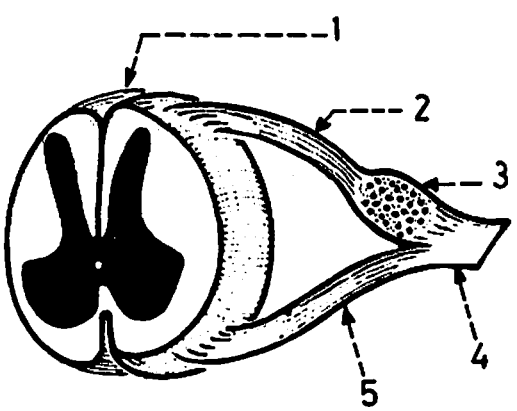


Fig.(6): ATTACHMENTS OF SPINAL NERVES

The spinal nerves are attached to the sides of the spinal cord by dorsal and ventral roots. The dorsal roots enter the cord at the posterolateral sulcus, while the ventral roots leave the cord at the anterolateral sulcus.

1. dorsal root of spinal nerve.
2. ventral root of spinal nerve.
3. trunk of spinal nerve.
4. dorsal root ganglion.

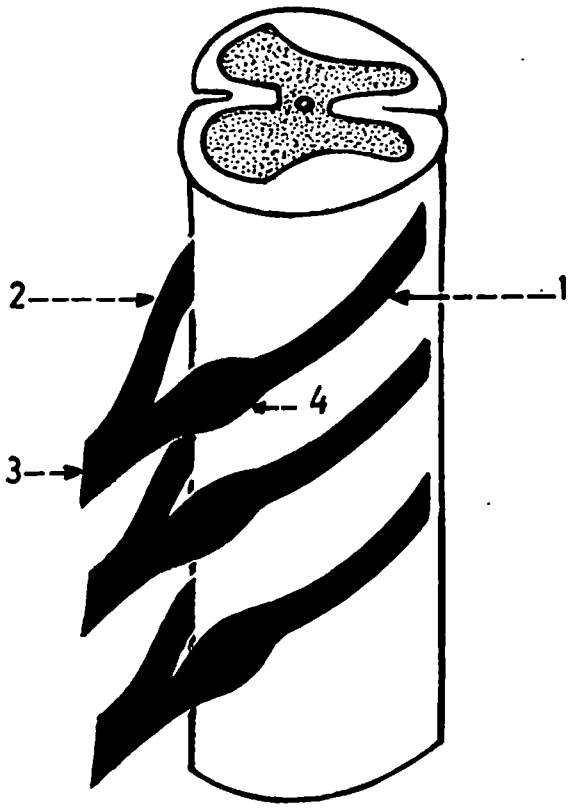
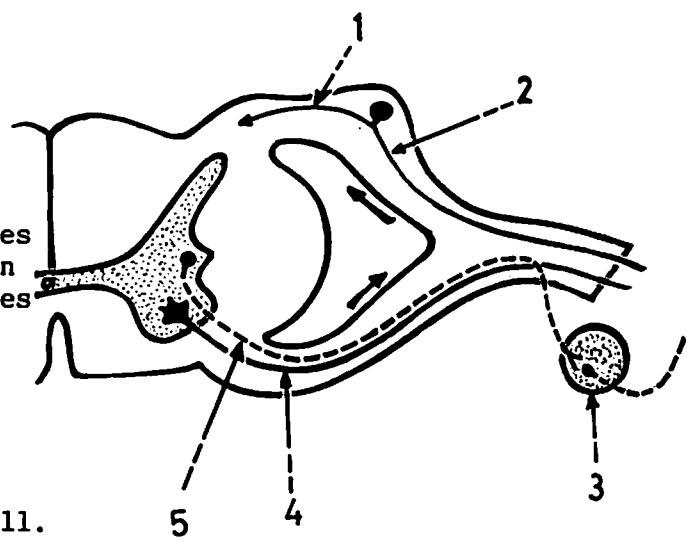


Fig.(7): TYPES OF FIBRES IN THE ROOTS OF SPINAL NERVES

The dorsal root consists of sensory fibres which are the processes of the unipolar cells of the dorsal root ganglion.
The ventral root consists of motor fibres which are the axons of the anterior horn cells, and preganglionic autonomic fibres which are the axons of cells in the lateral horn.

1. central process of unipolar cell in the dorsal root ganglion (sensory).
2. peripheral process of unipolar cell.
3. sympathetic ganglion.
4. motor fibre (axon of anterior horn cell).
5. preganglionic autonomic fibre.



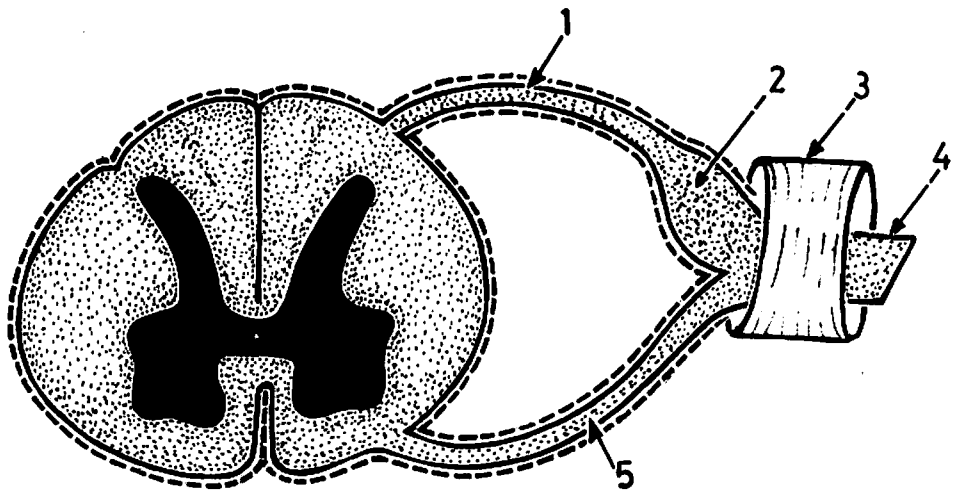


Fig.(8): POSITION OF THE TRUNK OF THE SPINAL NERVE

The trunk of the spinal nerve lies in the intervertebral foramen. However, the dorsal root ganglion lies close to the intervertebral foramen except the sacral ganglia which lie in the sacral canal.

1. dorsal root.
2. dorsal root ganglion.
3. intervertebral foramen.
4. trunk of spinal nerve.
5. ventral root.

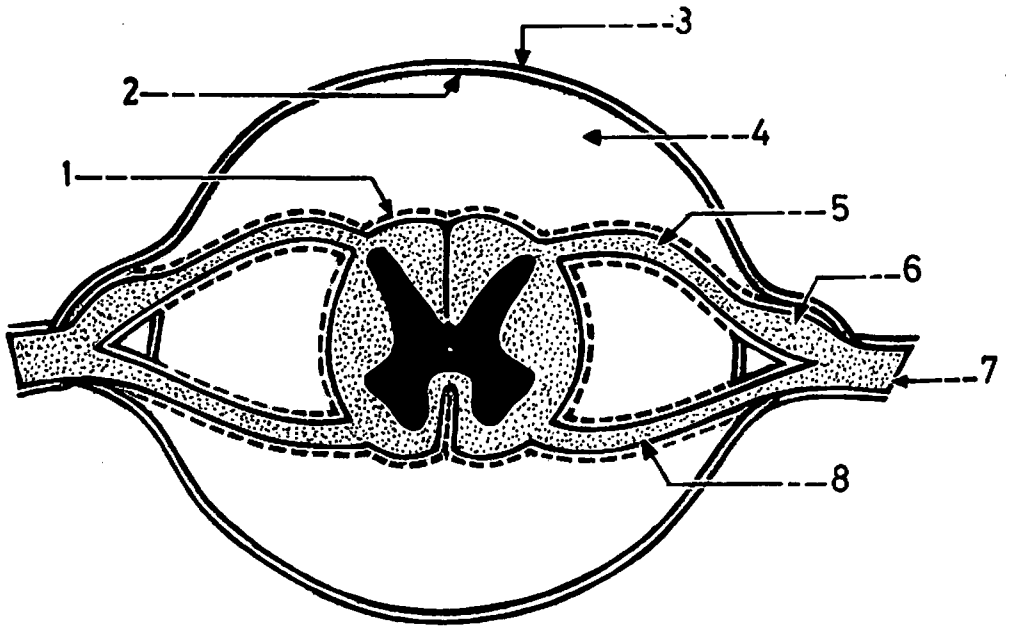


Fig.(9): MENINGEAL SHEATHS OF SPINAL NERVE

Each of the dorsal and ventral roots is surrounded by a sheath of pia mater. The 2 roots cross the subarachnoid space and pierce the arachnoid and dura mater separately.

1. pia mater.
2. arachnoid mater.
3. dura mater.
4. subarachnoid space.
5. dorsal root (covered by pia mater).
6. dorsal root ganglion.
7. trunk of spinal nerve.
8. ventral root (covered by pia mater).

* The dorsal root ganglion is covered by the pia, arachnoid and dura mater.

Fig.(10): DIRECTION AND LENGTH OF THE ROOTS OF SPINAL NERVES

* The 1st and 2nd cervical: their roots are the shortest and run horizontally.

* From the 3rd to the 8th cervical: their roots run obliquely downwards.

* The thoracic and upper lumbar: their roots increase in length and in obliquity from above downwards.

* The lower lumbar and all sacral: their roots are the longest and lie more vertical forming the cauda equina.

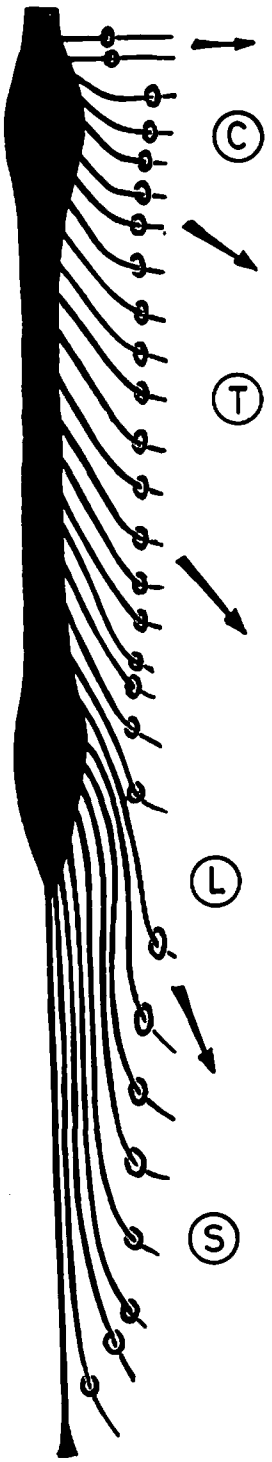
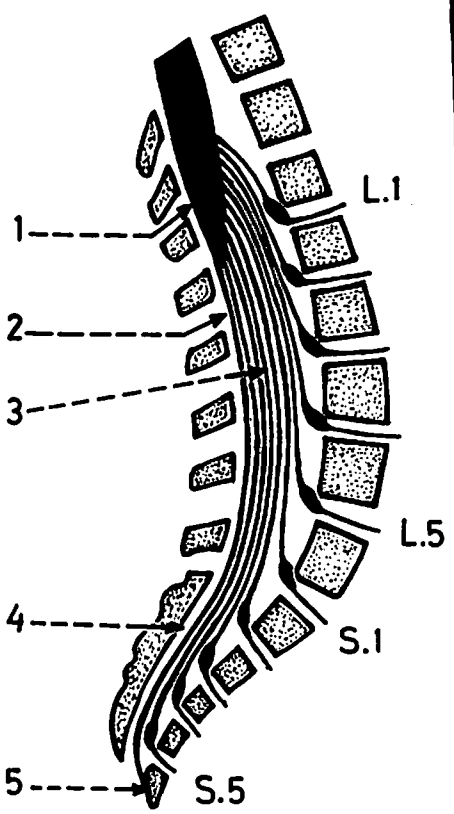


Fig.(11): CAUDA EQUINA

The cauda equina is formed by the roots of the lower lumbar, sacral and coccygeal nerves surrounding the filum terminale. It lies in the vertebral canal below the level of the 1st lumbar vertebra and extends into the sacral canal.

1. conus medullaris.
2. filum terminale.
3. roots of the spinal nerves forming the cauda equina.
4. sacral canal.
5. coccyx.

* Note that the dorsal root ganglia lie in the vertebral canal very close to the inter-vertebral foramina.



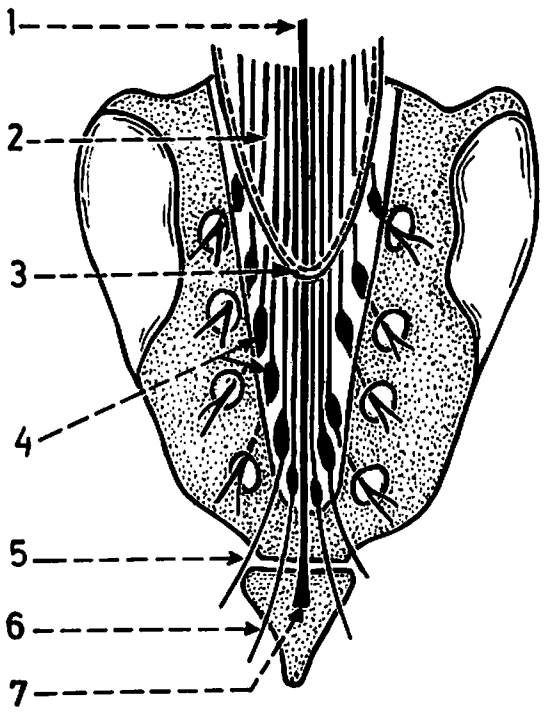


Fig.(12): SPINAL NERVES IN THE SACRAL CANAL
(the sacral canal is open from behind)

The sacral canal contains the roots of all sacral nerves and their spinal ganglia, in addition to the coccygeal nerve and the filum terminale. The dural and arachnoid tubes extend into the canal to the level of the 2nd sacral vertebra.

1. filum terminale.
2. cauda equina.
3. lower end of dural and arachnoid tubes.
4. spinal ganglia of sacral nerves.
5. 5th sacral nerve.
6. coccygeal nerve.
7. lower end of filum terminale.

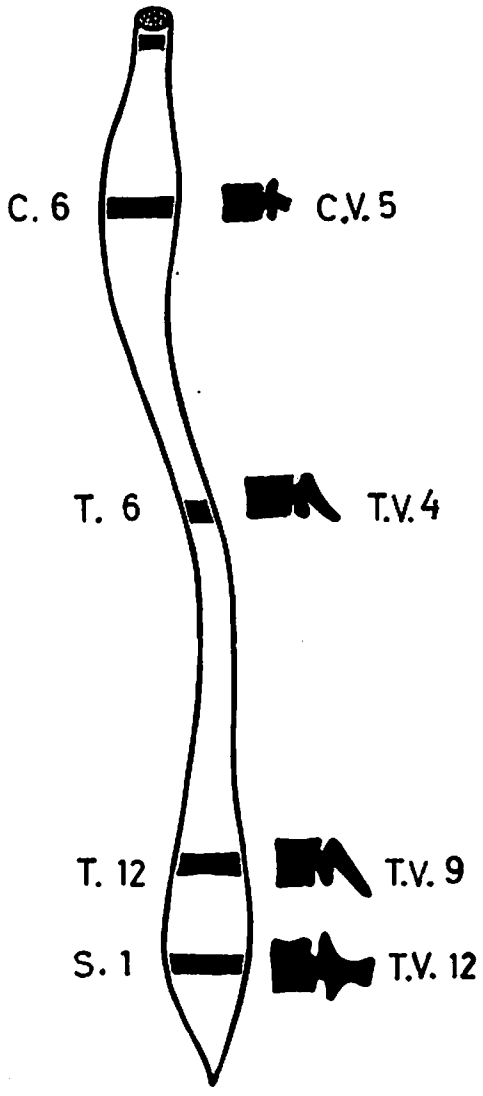


Fig.(13): LEVELS OF SPINAL SEGMENTS

Because the spinal cord is shorter than the vertebral canal, the spinal segments do not lie opposite the corresponding vertebrae.

* 6th cervical segment lies opposite 5th C.V.
* 6th thoracic segment lies opposite 4th T.V.
* 12th thoracic segment lies opposite 9th T.V.
* 1st sacral segment lies opposite 12th T.V.

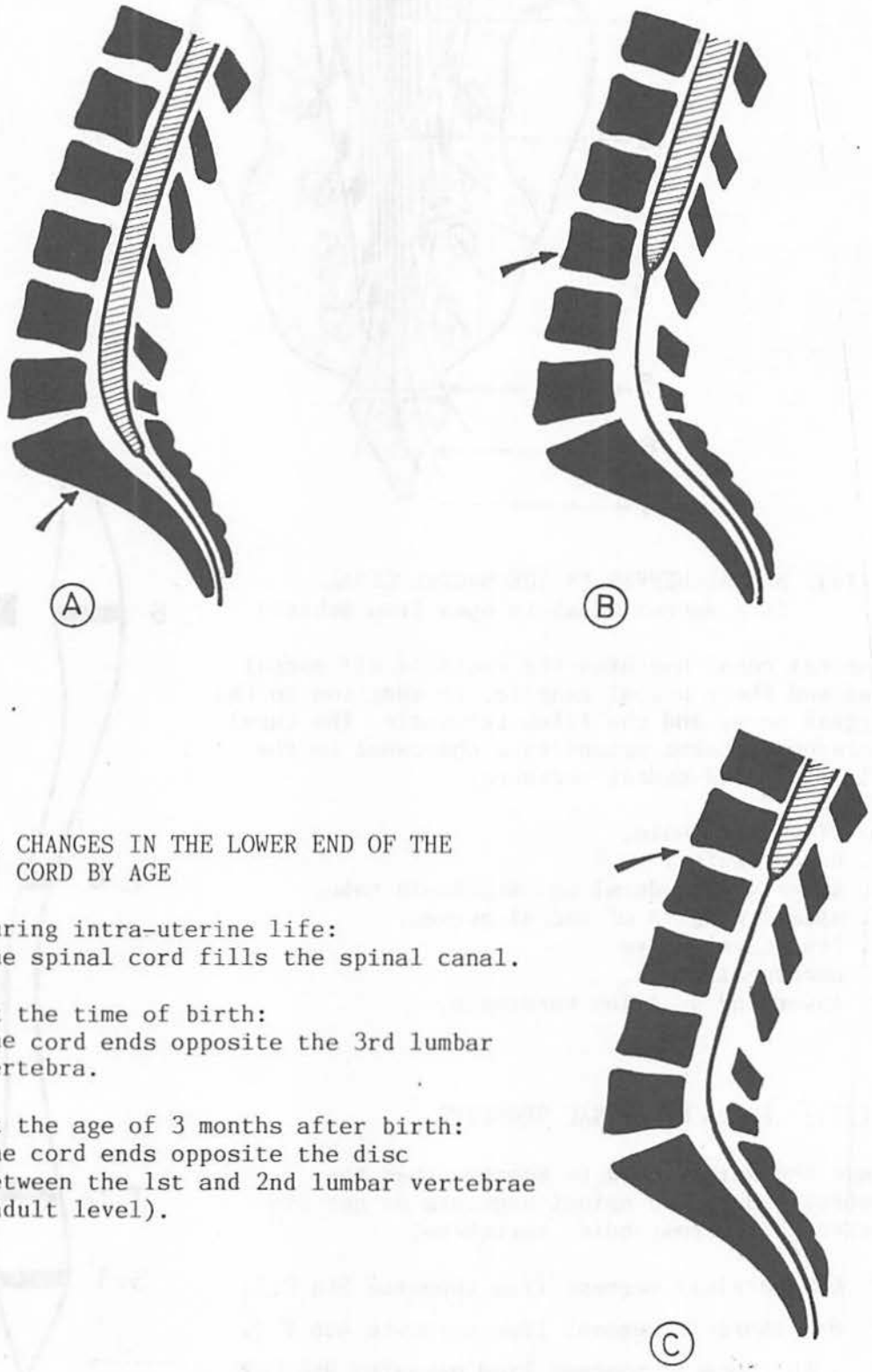


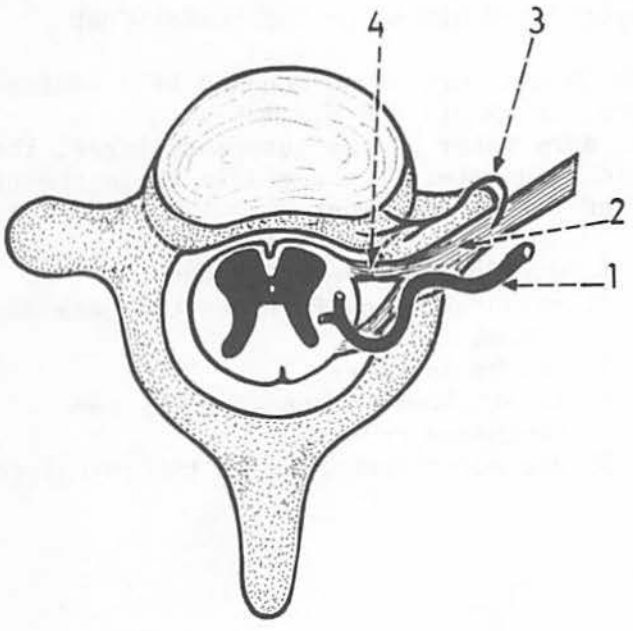
Fig.(14): CHANGES IN THE LOWER END OF THE CORD BY AGE

(A) During intra-uterine life:
the spinal cord fills the spinal canal.

(B) At the time of birth:
the cord ends opposite the 3rd lumbar vertebra.

(C) At the age of 3 months after birth:
the cord ends opposite the disc between the 1st and 2nd lumbar vertebrae (adult level).

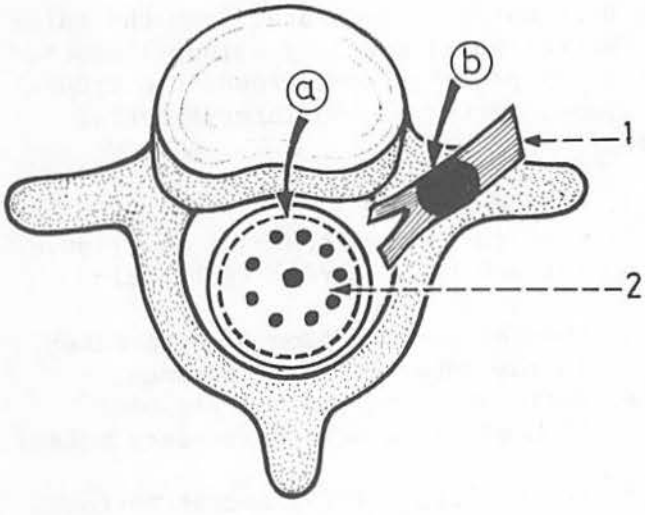
Fig.(15): SPINAL NERVE AS IT LEAVES THE VERTEBRAL CANAL



The roots of the spinal nerve lie within the vertebral canal, while the trunk of the nerve lies in the intervertebral foramen.

1. artery to the spinal cord passing through the intervertebral foramen.
2. trunk of spinal nerve in the intervertebral foramen.
3. recurrent meningeal nerve (supplies the dura mater).
4. ventral root of spinal nerve (in the vertebral canal).

Fig.(16): COMPRESSION OF THE CAUDA EQUINA AND TRUNK OF SPINAL NERVE



(a) Compression of cauda equina: the roots of spinal nerves forming the cauda equina (2) may be compressed by posterior prolapse of the intervertebral disc which is common between L.4 and L.5 or between L.5 and S.1.

(b) The trunk of spinal nerve (1) or its dorsal root ganglion may be compressed by postero-lateral prolapse of the intervertebral disc.

MENINGES OF SPINAL CORD

Fig.(17): MENINGES OF THE SPINAL CORD

The spinal cord is surrounded by 3 meninges: dura, arachnoid and pia mater.
The dura mater is the outermost layer, the arachnoid mater is the middle while the pia mater is the innermost.

1. dura mater (the strongest).
2. subdural space (between the dura and arachnoid).
3. arachnoid mater.
4. subarachnoid space (between the arachnoid and pia).
5. pia mater (adherent to the spinal cord).

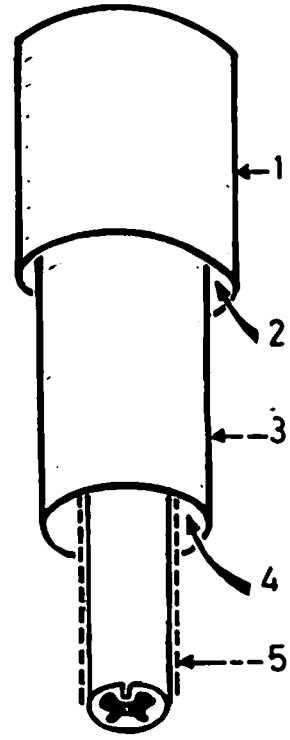


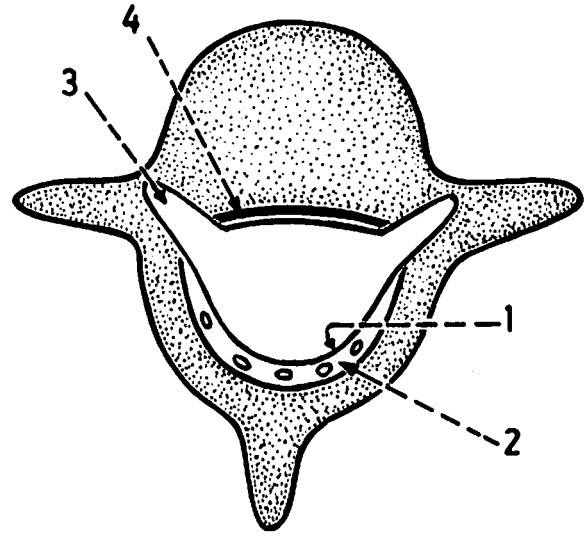
Fig.(18): DURA MATER AND EPIDURAL SPACE

The dura mater is separated from the walls of the vertebral canal by epidural space, and gives prolongations around the trunks of spinal nerves in the intervertebral foramina.

1. dura mater.
2. epidural space (contains semiliquid fat and the internal vertebral plexus of veins).
3. tubular prolongation of dura mater in the intervertebral foramen.
4. posterior longitudinal ligament (loosely attached to the dura mater).

* At the level of 2nd sacral vertebra the dural tube ends by forming a sheath for the filum terminale.

* The dura mater is mainly attached to the margins of the foramen magnum, all intervertebral foramina and back of the coccyx.



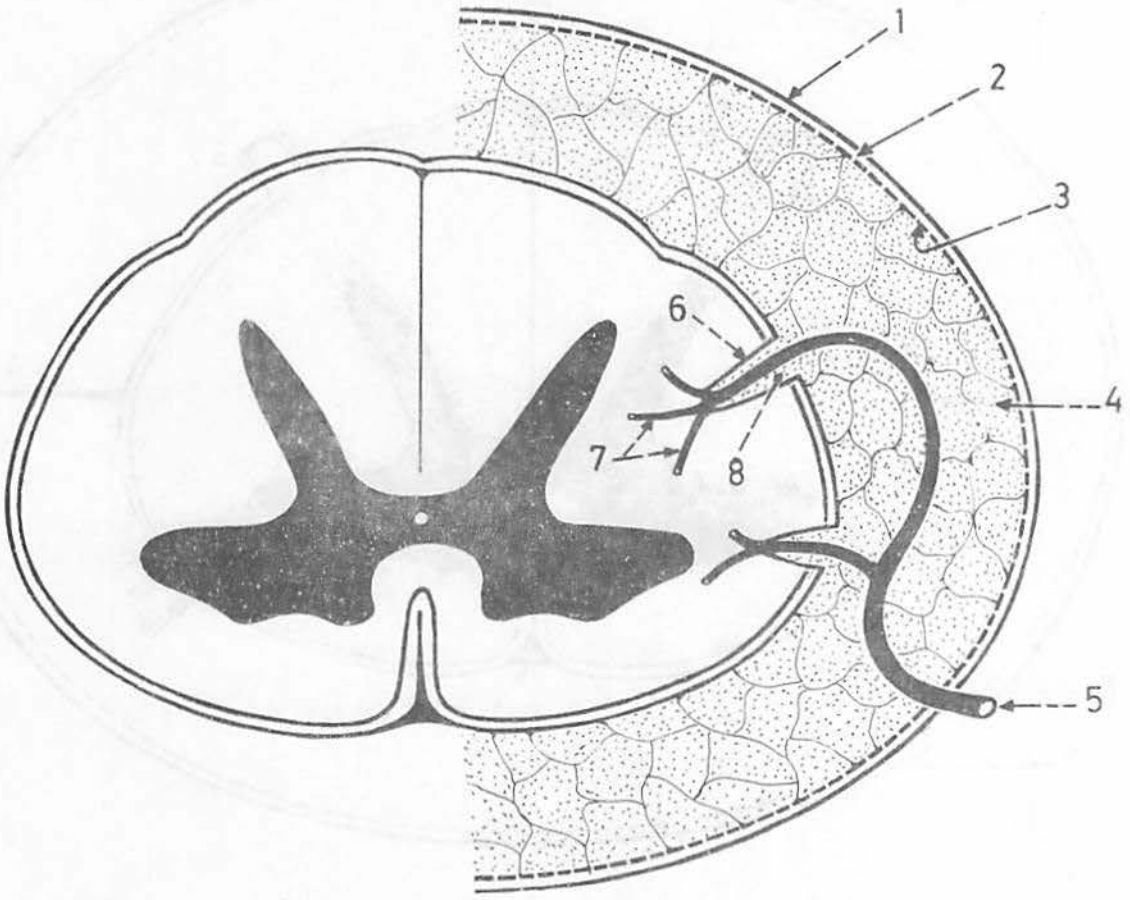


Fig.(19): ARACHNOID MATER AND SUBARACHNOID SPACE

1. dura mater.
2. subdural space (a narrow space between the dura and arachnoid, and contains a thin film of fluid).
3. arachnoid mater (a delicate membrane which sends fine fibrous strands in the subarachnoid space).
4. subarachnoid space (a wide space which is filled by cerebrospinal fluid and contains large blood vessels).
5. spinal artery.
6. a sleeve of pia mater surrounding the blood vessel as it pierces the substance of the spinal cord.
7. capillaries within the substance of the cord(not surrounded by perivascular space).
8. perivascular space (surrounds the artery and contains cerebrospinal fluid).

* The subarachnoid space is widest around the cauda equina, and ends below opposite the 2nd sacral vertebra.

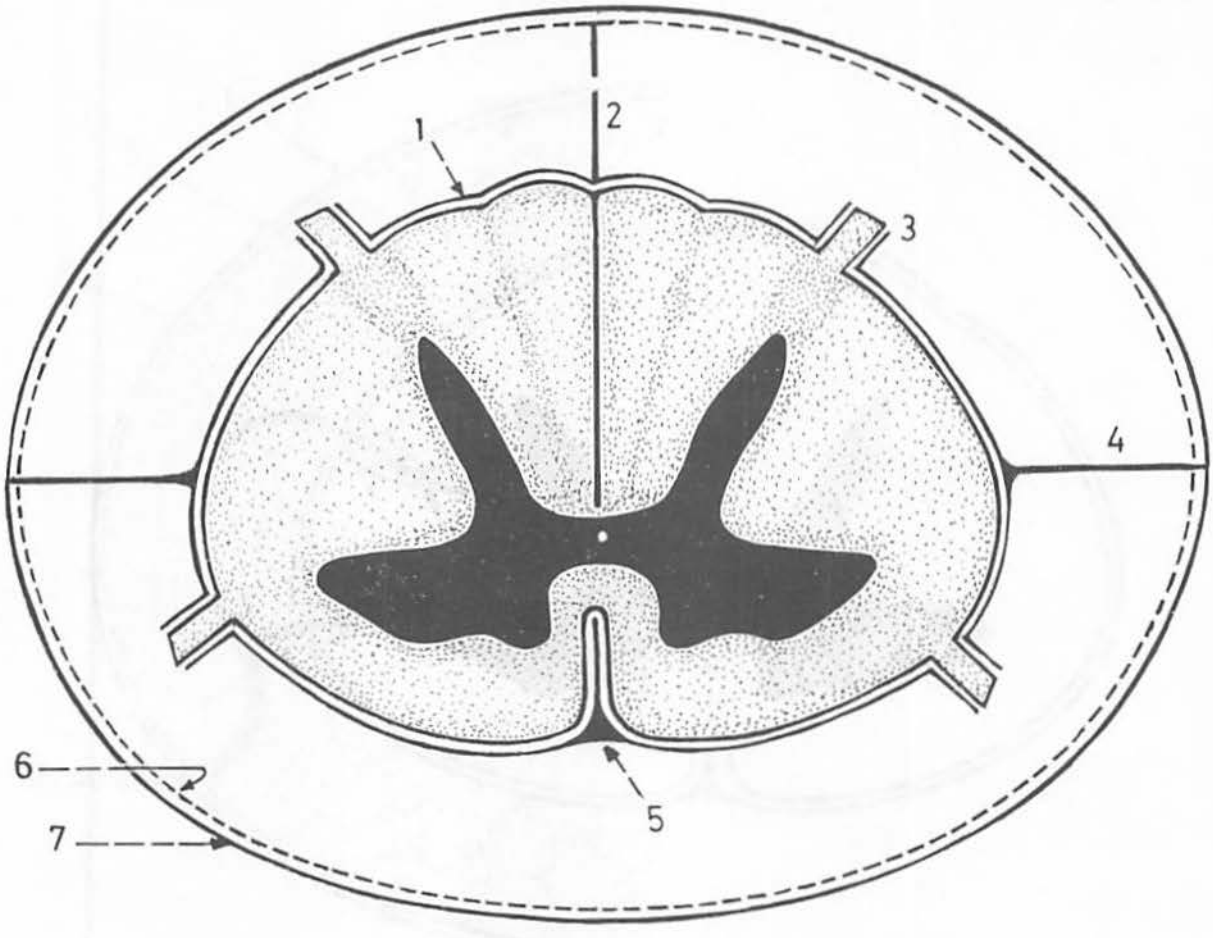


Fig.(20): PIA MATER

It is a delicate vascular membrane which is adherent to the surface of the spinal cord. It contains minute blood vessels and sends prolongations over the ventral and dorsal roots of spinal nerves. It forms the following fibrous bands: ligamenta denticulata, linea splendens, subarachnoid septum and filum terminale.

1. pia mater on the surface of the spinal cord.
2. subarachnoid septum (extends backwards in the median plane, in the subarachnoid space).
3. prolongation of pia mater around the posterior root of spinal nerve.
4. ligamentum denticulatum (extends laterally from the side of the cord in the subarachnoid space as far as the dura mater).
5. linea splendens (a thickened band of pia mater in the anterior median fissure).
6. arachnoid mater.
7. dura mater

* The subarachnoid space is partially divided by the subarachnoid septum (behind) and the ligamenta denticulata (on the sides).

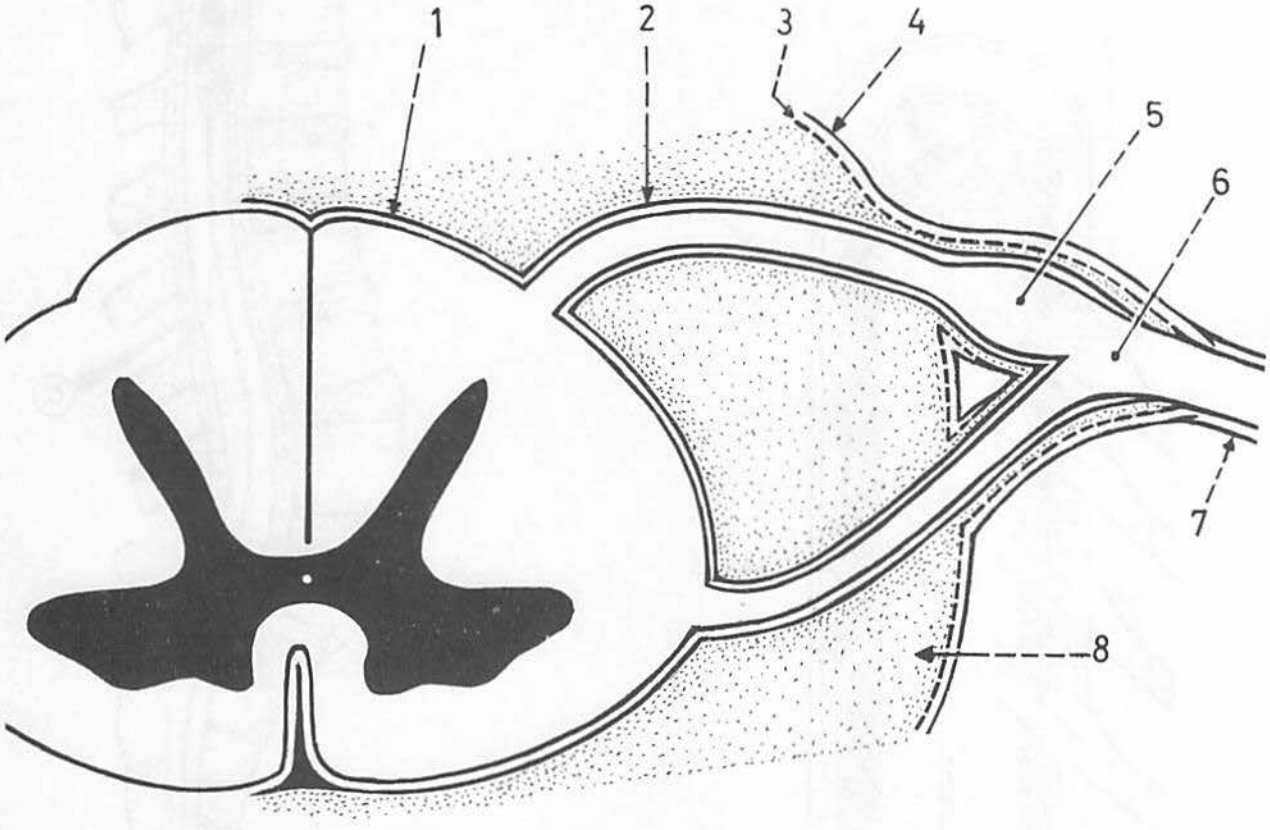


Fig.(21): PROLONGATIONS OF THE MENINGES OVER THE ROOTS AND TRUNK OF SPINAL NERVE

The dorsal and ventral roots of spinal nerve traverse the subarachnoid space and are surrounded by a sheath of pia mater, while the trunk of the nerve lies within the intervertebral foramen and is surrounded by the 3 meninges (pia, arachnoid and dura). Just outside the intervertebral foramen, the dural sheath is continuous with the epineurium surrounding the nerve.

1. pia mater.
2. sheath of pia mater around the dorsal root.
3. arachnoid mater.
4. dura mater.
5. dorsal root ganglion (surrounded by the 3 meninges).
6. trunk of spinal nerve (surrounded by the 3 meninges).
7. epineurium (neurolemmal sheath) of the nerve.
8. subarachnoid space.

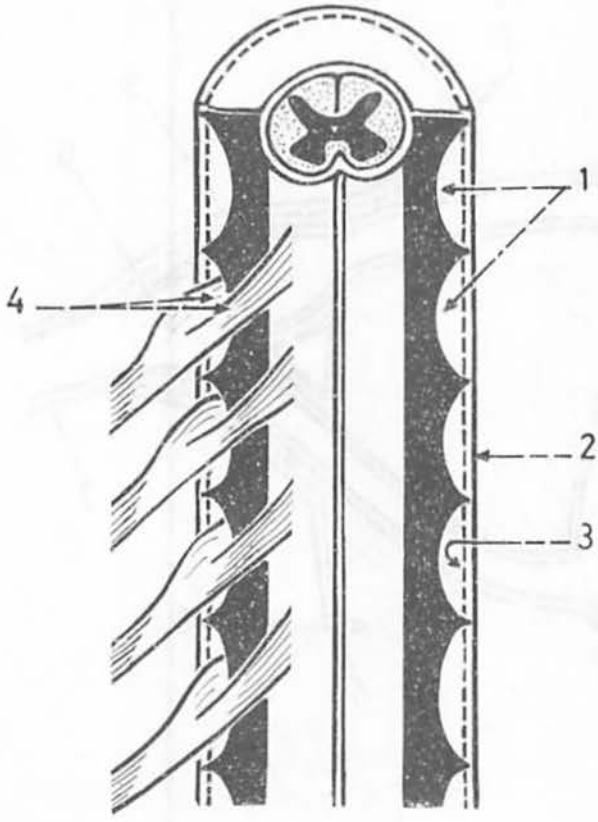


Fig.(22): LIGAMENTA DENTICULATA

These are 2 longitudinal bands of pia extending one on each side of the cord. Each ligamentum denticulatum lies midway between the ventral and dorsal roots, and its lateral border shows 21 tooth-like processes which are attached to the dura mater.

1. lateral border of ligamentum denticulatum (serrated).
2. dura mater.
3. arachnoid mater.
4. the 2 roots of spinal nerve, one on each side of the ligament.

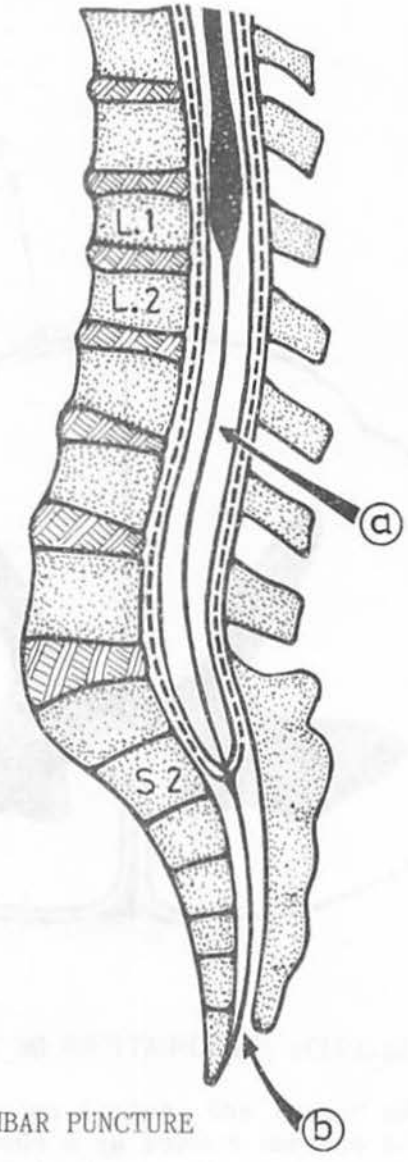


Fig.(23): LUMBAR PUNCTURE

It is the procedure of introducing a needle in the subarachnoid space to get a sample of cerebrospinal fluid (C.S.F.). The needle is inserted between the laminae of the 3rd and 4th, or 4th and 5th lumbar vertebrae.

(a) lumbar puncture.

(b) injection into the epidural space through the lower end of the sacral canal (sacral hiatus).

VESSELS OF SPINAL CORD

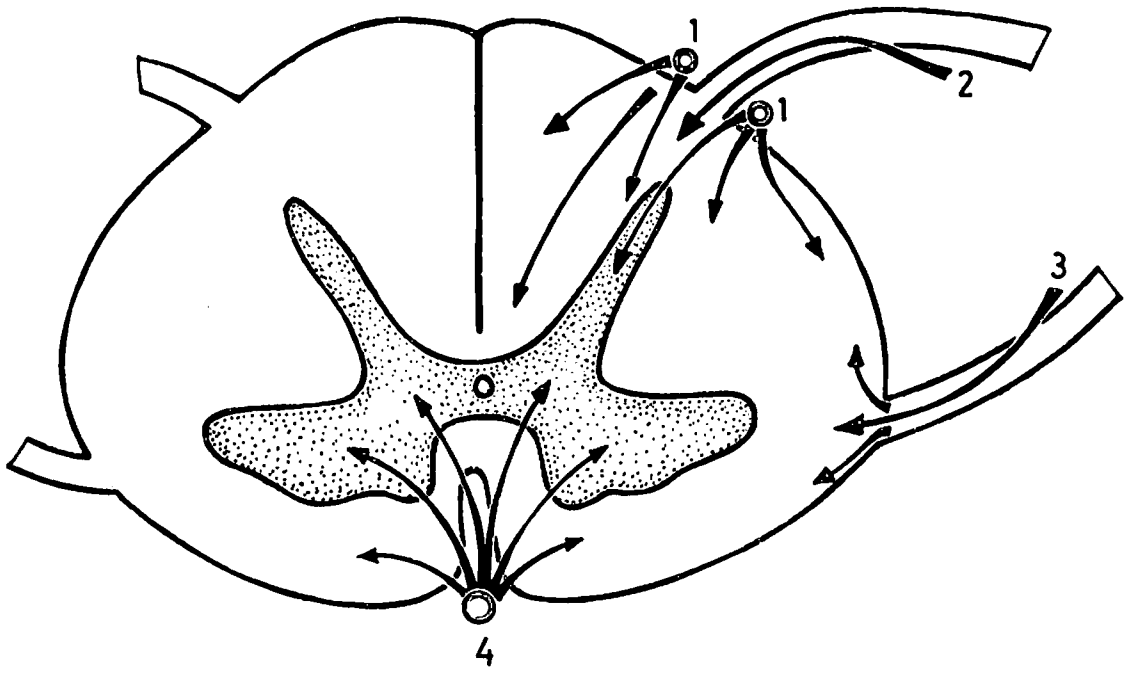


Fig.(24): ARTERIES OF THE SPINAL CORD

The spinal cord is supplied by the anterior spinal artery (from the 4th part of vertebral artery), posterior spinal artery (from the 4th part of vertebral) and radicular arteries (from the vertebral, posterior intercostal and lumbar arteries).

1. branches of the posterior spinal artery (one in front and one behind the dorsal root of spinal nerve).
2. radicular artery along the dorsal root.
3. radicular artery along the ventral root.
4. anterior spinal artery (in the anterior median fissure).

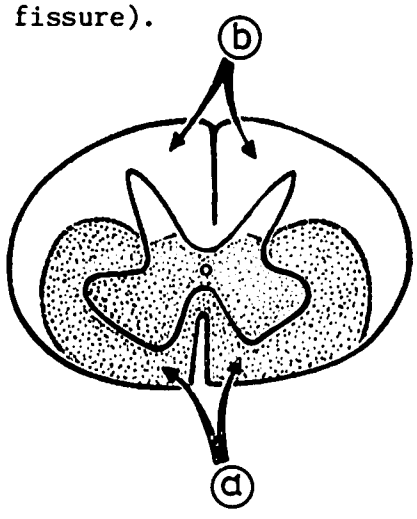


Fig.(25): DISTRIBUTION OF THE ARTERIES OF THE SPINAL CORD

(a) Area supplied by the anterior spinal artery (anterior horns, bases of posterior horns, anterior funiculi and parts of the lateral funiculi).

(b) Area supplied by the posterior spinal and radicular arteries (posterior horns, posterior funiculi and parts of lateral funiculi).

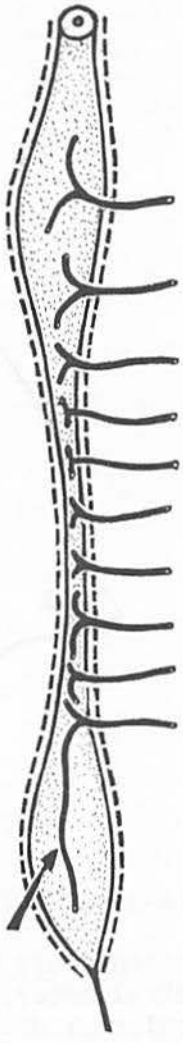


Fig.(26): RADICULAR ARTERIES

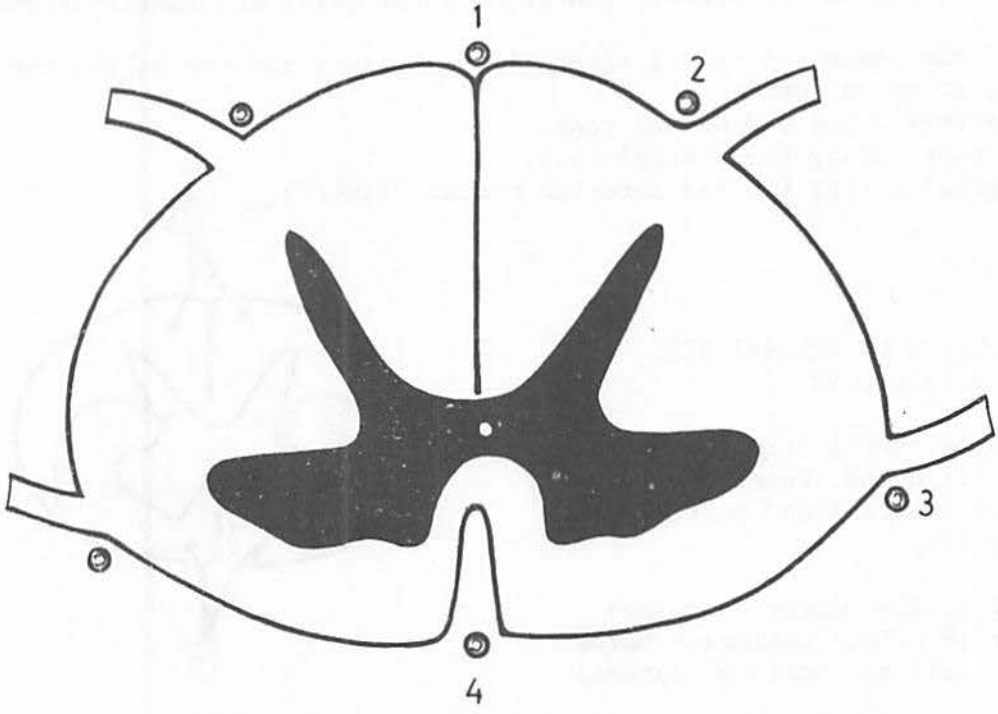
These are branches from the vertebral, posterior intercostal and lumbar arteries which enter the vertebral canal through the intervertebral foramina. They run along the ventral and dorsal roots of spinal nerves to reach the spinal cord where they anastomose together.
One of the radicular arteries is especially large and is called the arteria radicularis magna (arrow). It supplies the lumbar enlargement of the cord.

Fig.(27): VEINS OF THE SPINAL CORD

These are 6 longitudinal venous chains which run along the surface of the cord.

1. a chain along the posterior median sulcus.
2. a chain along the dorsal root (one on each side).
3. a chain along the ventral root (one on each side).
4. a chain along the anterior median fissure.

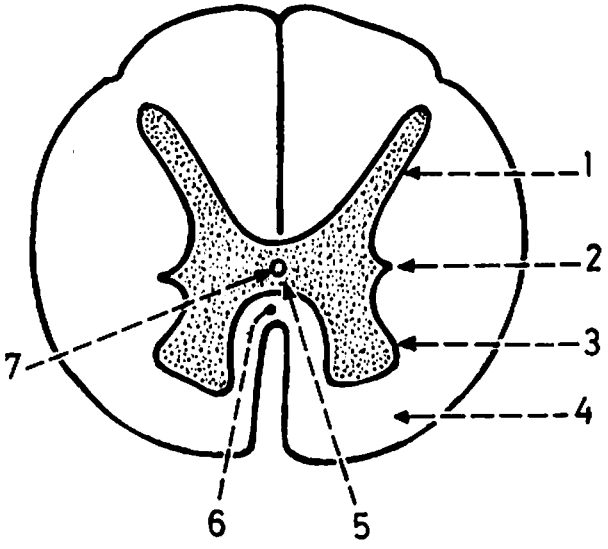
* These veins communicate with the internal vertebral plexus of veins as well as with the dural sinuses inside the skull.



INTERNAL STRUCTURE OF SPINAL CORD

GREY MATTER

Fig.(28): SPINAL CORD IN CROSS SECTION

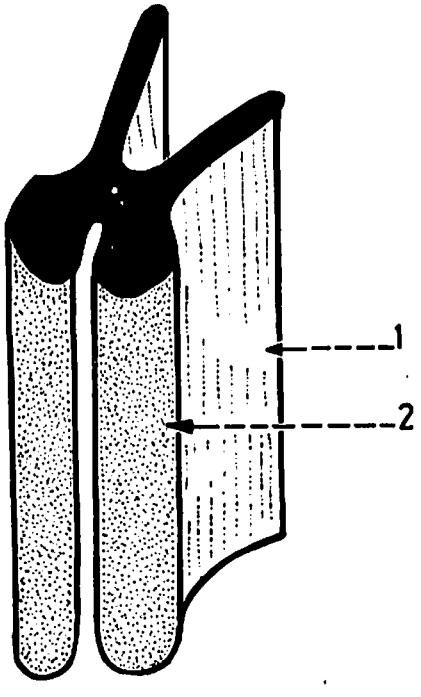


The spinal cord consists of a core of H-shaped grey matter surrounded by an outer layer of white matter.The grey matter is formed by bodies of nerve cells, while the white matter is formed by tracts of myelinated nerve fibres.
The grey matter has 2 anterior horns and 2 posterior horns. The horns of the 2 sides are connected together by a transverse bar of grey matter called grey commissure which is traversed by the central canal.

1. posterior horn (contains sensory cells).
2. lateral horn (contains autonomic cells).
3. anterior horn (contains motor cells called anterior horn cells).
4. white matter.
5. grey commissure (grey matter).
6. white commissure (white matter).
7. central canal (in the grey commissure).

* The lateral horn exists only in all thoracic, upper 2 or 3 lumbar and 2nd, 3rd and 4th sacral segments.

Fig.(29): COLUMNS OF GREY MATTER



Through the whole length of the spinal cord, the horns of grey matter form anterior and posterior grey columns.

1. posterior grey column.
2. anterior grey column.

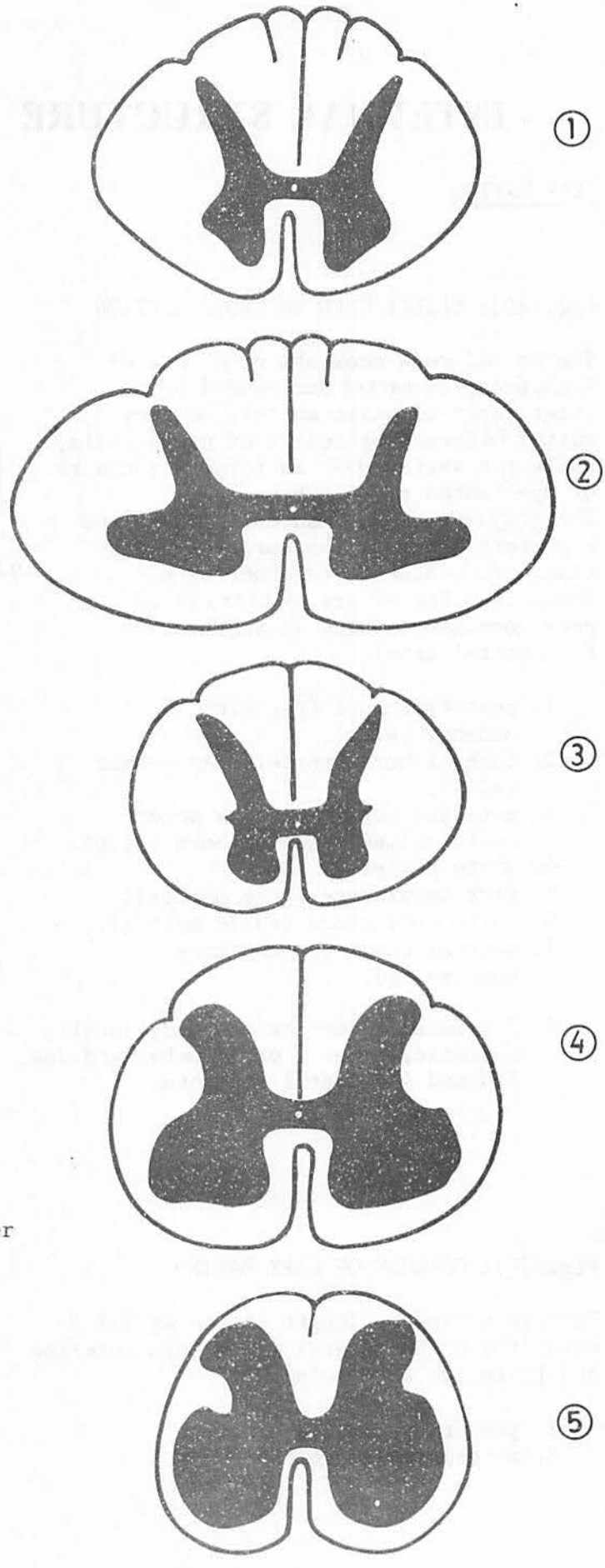


Fig.(30): CROSS SECTION OF SPINAL CORD AT DIFFERENT LEVELS

The amount of grey matter varies at different levels of spinal cord, being greater at the cervical and lumbar enlargements and lesser in the thoracic and upper cervical regions.

1. level of 3rd cervical segment: the grey matter is small in size with absent lateral horns.

2. level of 6th cervical segment: the grey matter is large in size and the white matter is also large in size.

3. level of 6th thoracic segment: the grey matter is small in size with the presence of lateral horns.

4. level of 3rd lumbar segment: the grey matter is markedly enlarged in size, while the white matter is reduced in size.

5. level of 2nd sacral segment: the grey matter is markedly enlarged in size, while the white matter is markedly reduced in size.

* Note that the white matter decreases in amount from above downwards, while the grey matter increases only at the cervical and lumbar enlargements.

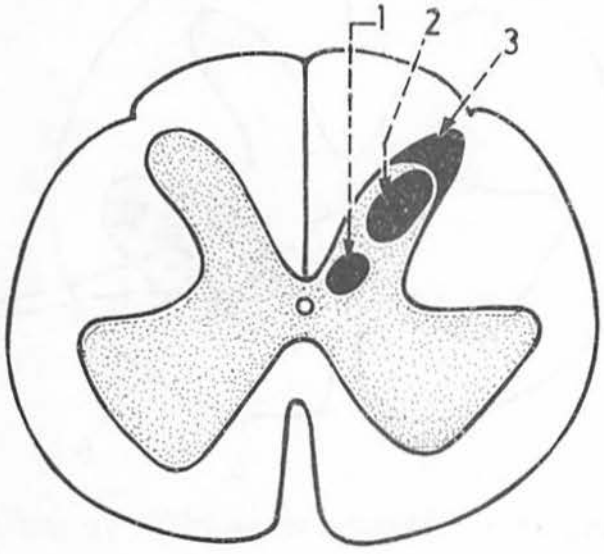


Fig.(31): NUCLEI OF POSTERIOR HORN

These are mainly the substantia gelatinosa (of Rolando), nucleus proprius, and thoracic nucleus (of Clarke).

1. thoracic nucleus (at the base of the horn extending from C.8 to L.3; it gives origin to the posterior spino-cerebellar tract).
2. nucleus proprius (in the middle of the horn; it gives origin to the anterior spino-thalamic tract).
3. substantia gelatinosa (at the tip of the horn; it gives origin to the lateral spino-thalamic tract).

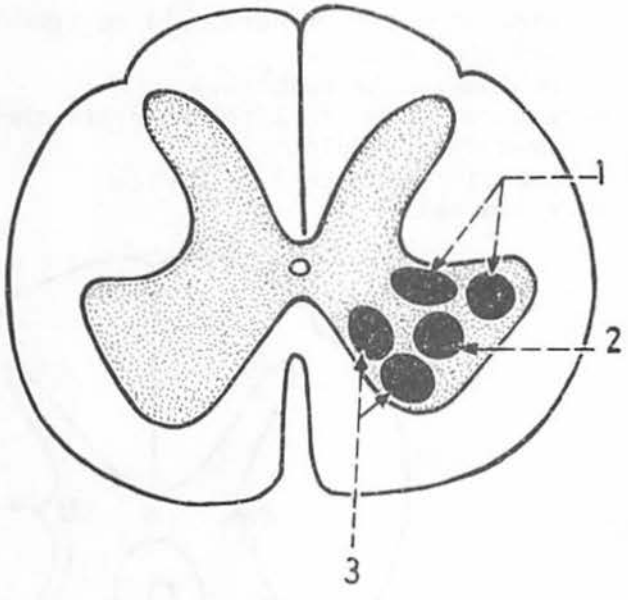


Fig.(32): NUCLEI OF ANTERIOR HORN

These are medial, lateral and central.

1. lateral nuclei (for muscles of the limbs).
2. central nucleus (only present in the cervical region; it gives origin to the phrenic nerve and spinal root of accessory nerve).
3. medial nuclei (for muscles of the trunk).

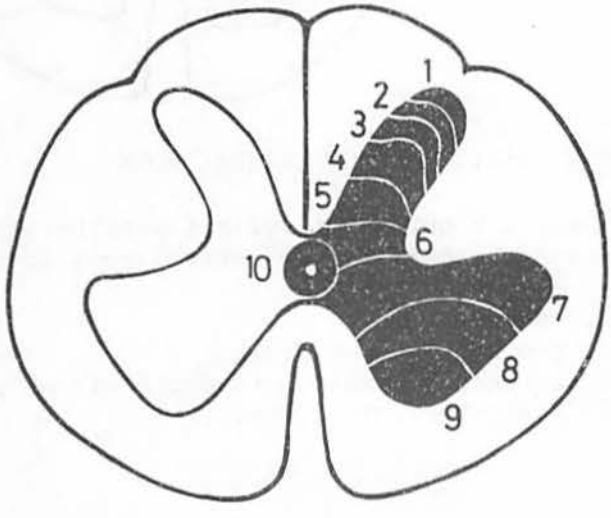


Fig.(33): LAMINAE OF GREY MATTER OF SPINAL CORD

In another way of classification, the grey matter of the cord is described to cosist of 10 laminae starting from the apex of the posterior horn (lamina 1), and progressing ventrally towards the anterior horn. The layer which surrounds the central canal is lamina 10.

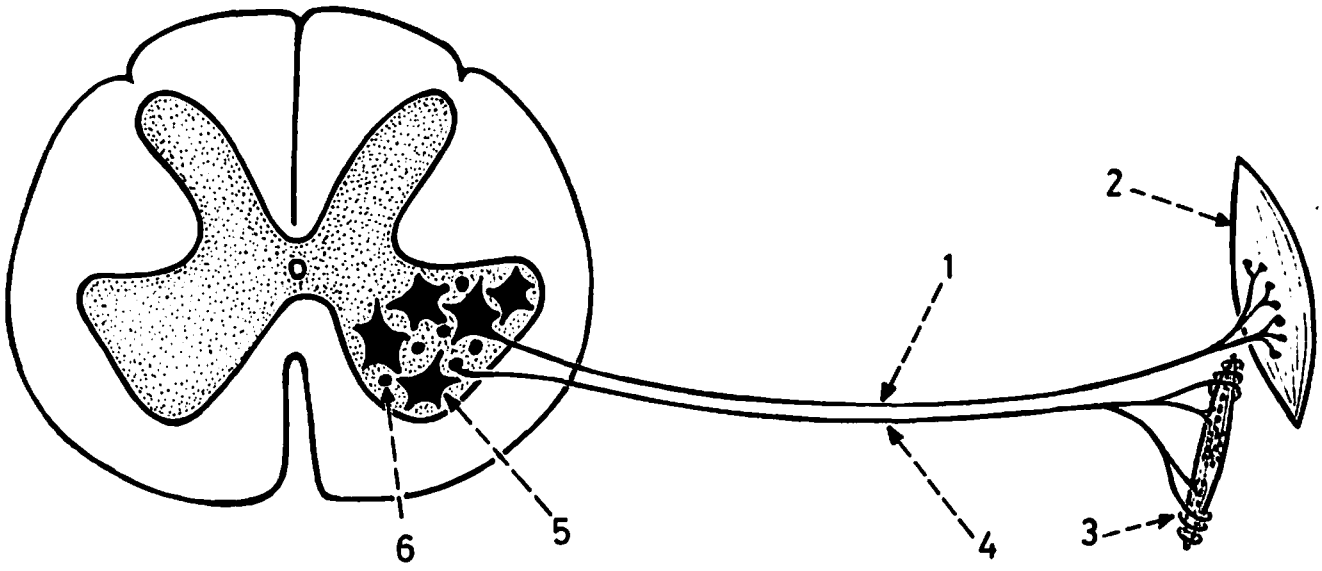


Fig.(34): TYPES OF NERVE CELLS IN THE ANTERIOR HORN

These are 2 types: large cells called anterior horn cells and small gamma cells.

1. axon of anterior horn cell to innervate skeletal muscle.
2. skeletal muscle.
3. neuromuscular spindle.
4. axon of gamma cell to innervate the intrafusal muscle fibres of neuromuscular spindle.
5. anterior horn cell (A.H.C.).
6. gamma cell.

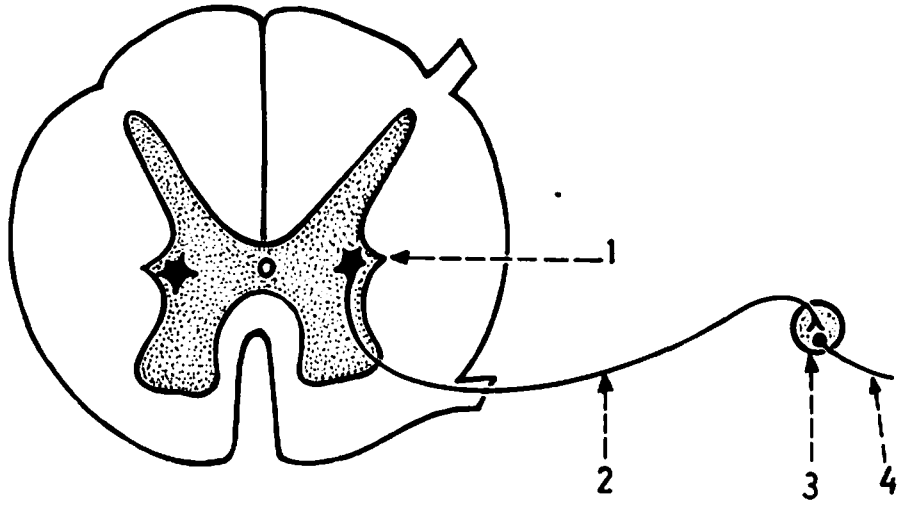


Fig.(35): CELLS OF LATERAL HORN

These are autonomic cells (sympathetic or parasympathetic) and their fibres leave the cord in the ventral root of spinal nerve as preganglionic fibres.

1. lateral horn.
2. preganglionic fibre.
3. autonomic ganglion (sympathetic or parasympathetic).
4. postganglionic fibre.

WHITE MATTER

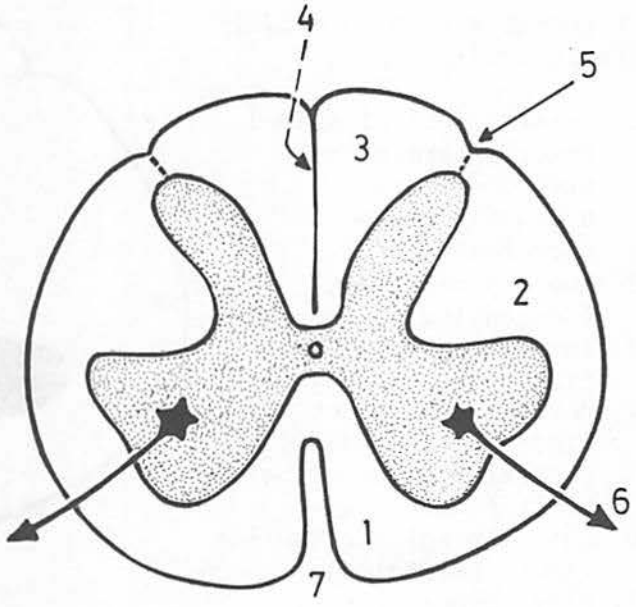


Fig.(36): FUNICULI OF SPINAL CORD

The white matter of the cord is divided into 3 funiculi or columns: anterior, lateral and posterior. Each funiculus consists of a number of tracts or fasciculi.

1. anterior funiculus (between the anterior median fissure and the emerging ventral roots of spinal nerves).
2. lateral funiculus (between the attachments of the ventral and dorsal roots of spinal nerves).
3. posterior funiculus (between the the posterior median septum and attachments of the posterior roots of spinal nerves).
4. posterior median septum.
5. posterolateral sulcus where the posterior roots are attached.
6. emerging ventral root of spinal nerve.
7. anterior median fissure.

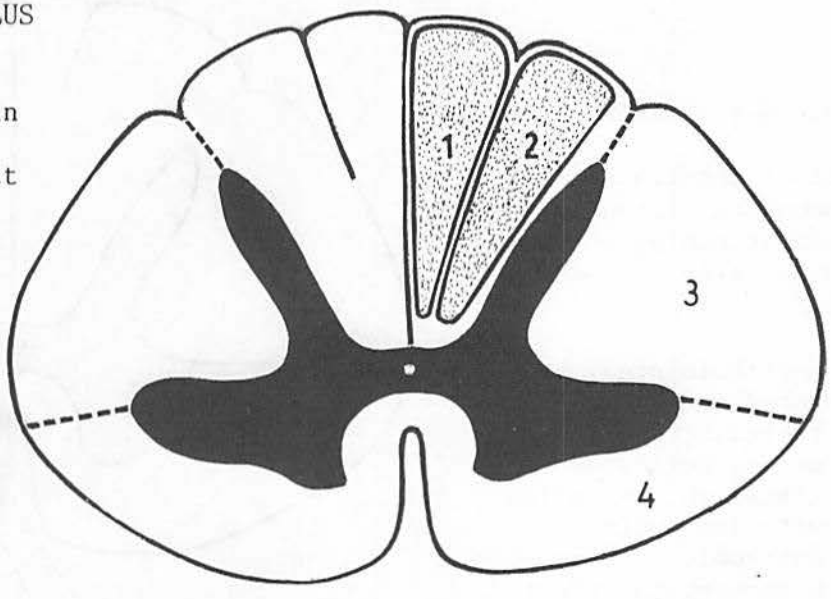


Fig.(37): POSTERIOR FUNICULUS

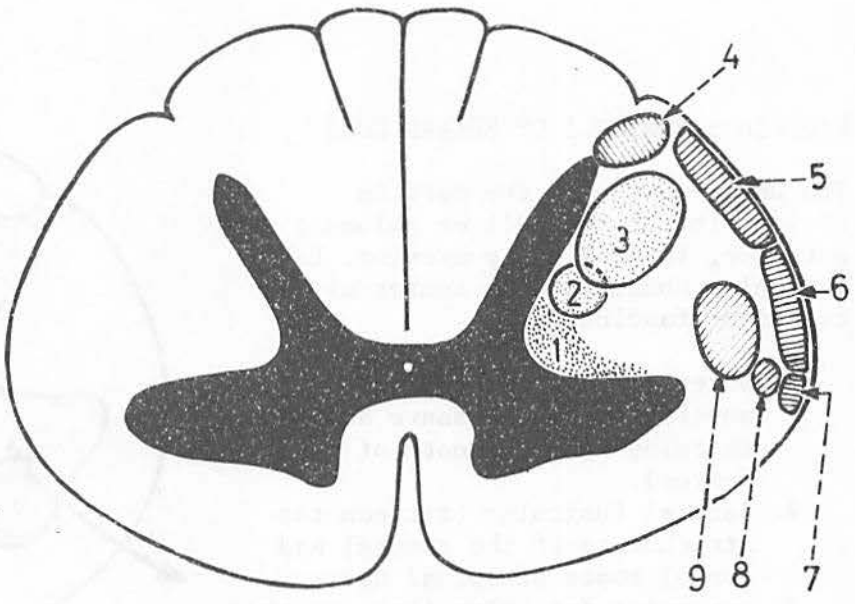
It consists of ascending (sensory) fibres arranged in 2 tracts: gracile tract (medially) and cuneate tract (laterally). These tracts carry proprioceptive sensations and fine touch.

1. gracile tract (medial).
2. cuneate tract (lateral).
3. lateral funiculus.
4. anterior funiculus.

Fig.(38): LATERAL FUNICULUS

It contains both ascending and descending tracts.

1. lateral reticulospinal tract intermingling with descending autonomic fibres (descending).
2. rubrospinal tract (descending).
3. lateral corticospinal tract (descending).
4. dorsolateral tract of Lissauer (ascending).
5. posterior spinocerebellar tract (ascending).
6. anterior spinocerebellar tract (ascending).
7. olivospinal tract (descending)intermingling with spinoolivary tract (ascending).
8. spinotectal tract (ascending).
9. lateral spinothalamic tract (ascending).



* In the lateral funiculus the descending motor tracts are situated deeply close to the grey matter, while the ascending tracts are mainly situated near the surface of the cord.

Fig.(39): ANTERIOR FUNICULUS

Most of its tracts are descending with only one tract ascending which is the anterior spinothalamic tract.

1. vestibulospinal tract.
2. anterior (ventral) spinothalamic tract.
3. medial reticulospinal fibres intermingling with descending autonomic fibres.
4. sulcomarginal tract.
5. anterior corticospinal tract.
6. tectospinal tract.

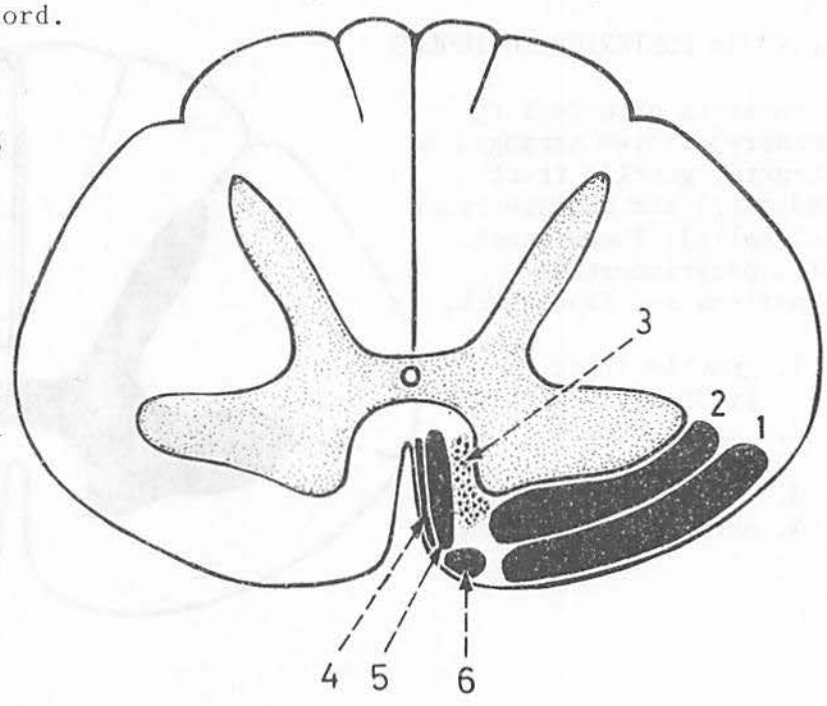


Fig.(40): INTERSEGMENTAL TRACTS

These are fibres which connect the various segments of the spinal cord together.

1. septomarginal tract.
2, posterior intersegmental tract.
3. lateral intersegmental tract.
4. anterior intersegmental tract.

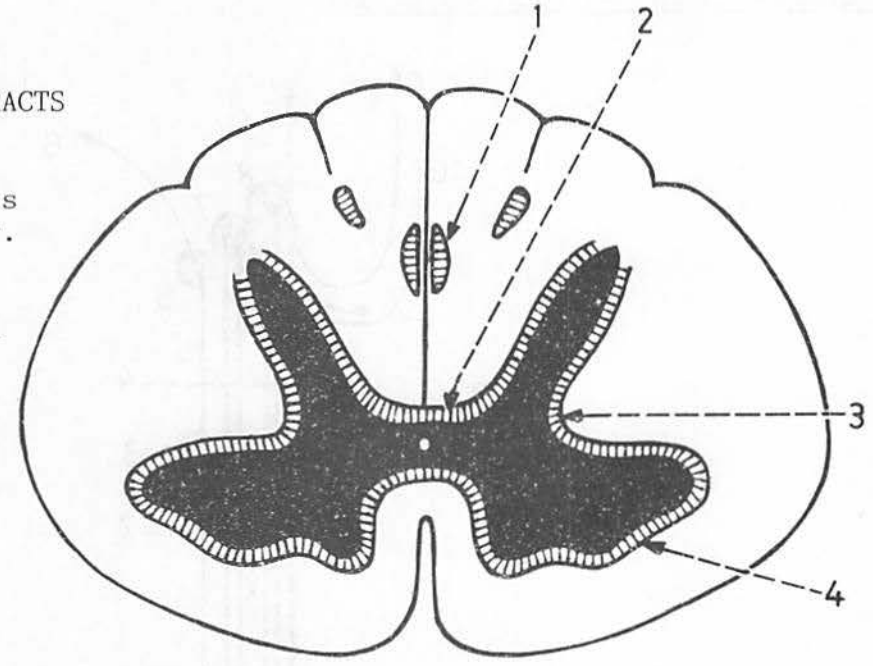
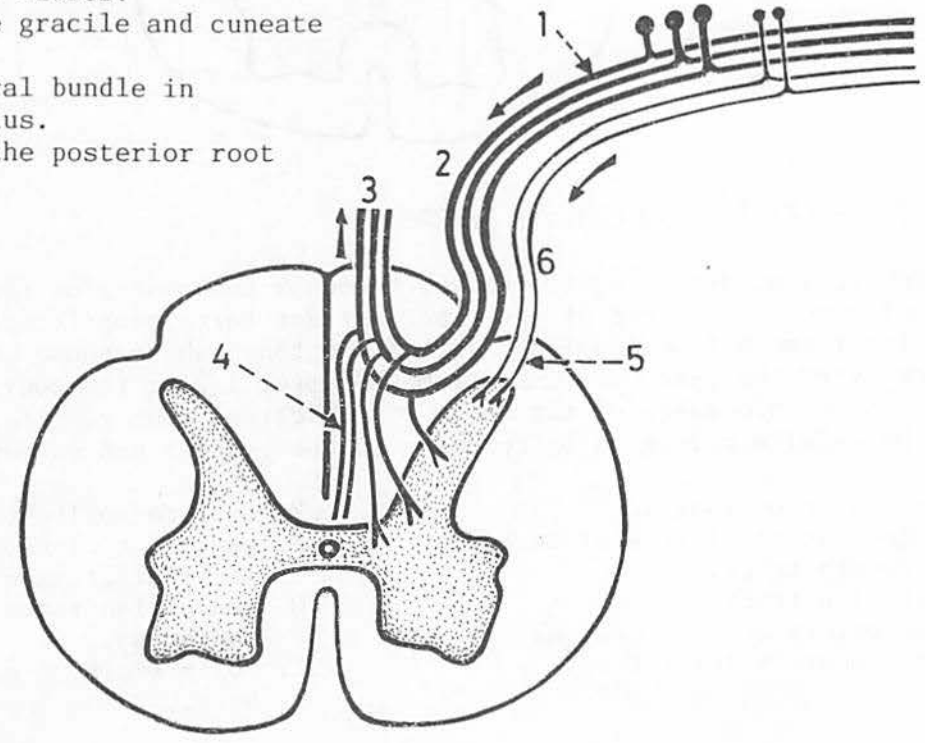


Fig.(41): MEDIAL AND LATERAL BUNDLES OF THE POSTERIOR ROOT OF SPINAL NERVE

The fibres of the posterior root are arranged in 2 bundles as they enter the cord (medial and lateral). The medial bundle enters the posterior funiculus and carries proprioceptive and touch sensations.The lateral bundle enters the lateral funiculus and carries pain and temperature sensations.

1. central processes of the cells of the dorsal root ganglion.
2. medial bundle of the posterior root (thick fibres).
3. gracile and cuneate fibres.
4. collaterals from the gracile and cuneate fibres.
5. fibres of the lateral bundle in the lateral funiculus.
6. lateral bundle of the posterior root (thin fibres).



ASCENDING TRACTS IN THE SPINAL CORD

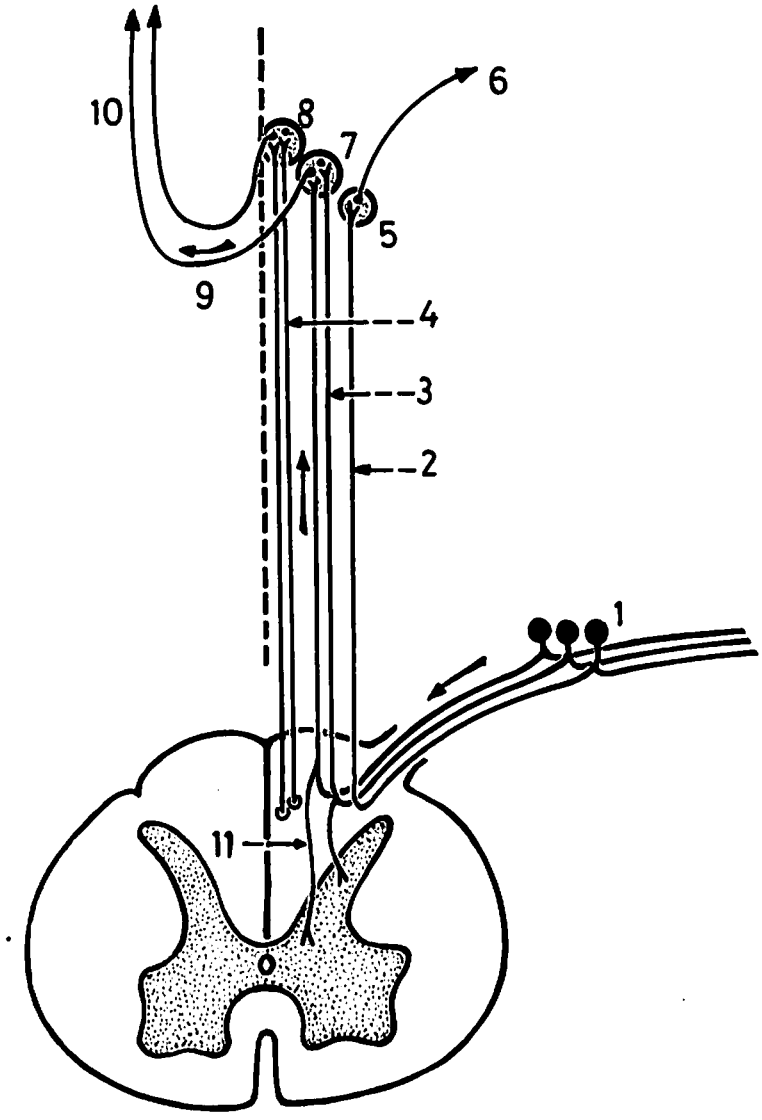


Fig.(42): GRACILE AND CUNEATE TRACTS

These are long ascending fibres which occupy the posterior funiculus of the spinal cord. The fibres of the gracile tract carry proprioceptive sensations and light touch from the lower 1/2 of the body, while those of the cuneate tract carry the same sensations from the upper 1/2 of the body. Both tracts are the central processes of the cells of the dorsal root ganglia, and they end in the medulla oblongata by relaying in the gracile and cuneate nuclei.

1. dorsal root ganglion.
2. most lateral fibres of cuneate tract.
3. cuneate tract.
4. gracile tract.
5. accessory cuneate nucleus.
6. cuneocerebellar fibres.
7. cuneate nucleus.
8. gracile nucleus.
9. internal arcuate fibres.
10. medial lemniscus (ascending to the thalamus).
11. collaterals to nuclei of the posterior horn.

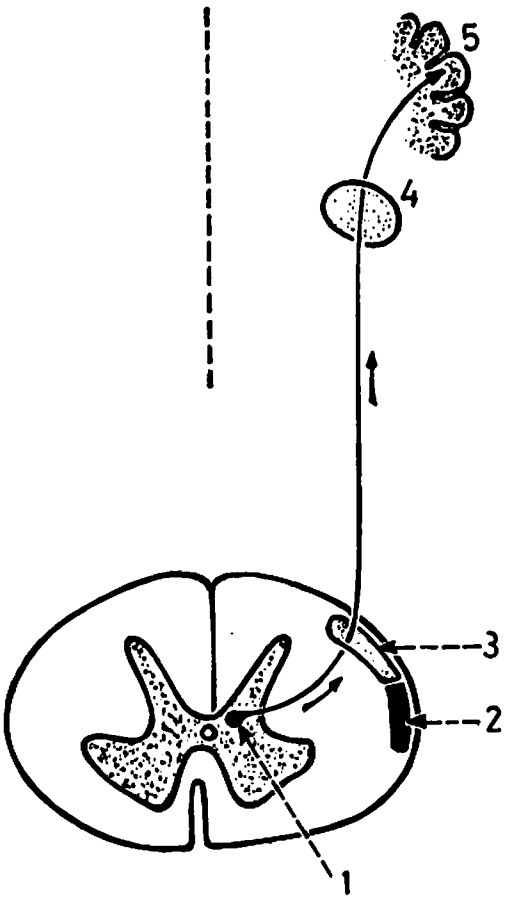


Fig.(43): POSTERIOR SPINOCEREBELLAR TRACT

Its fibres are the axons of the thoracic nucleus of Clarke of the same side. It carries proprioceptive sensations and reaches the cerebellar hemisphere of the same side through the inferior cerebellar peduncle.

1. thoracic nucleus of Clarke.
2. anterior spinocerebellar tract.
3. posterior spinocerebellar tract.
4. inferior cerebellar peduncle.
5. cerebellum.

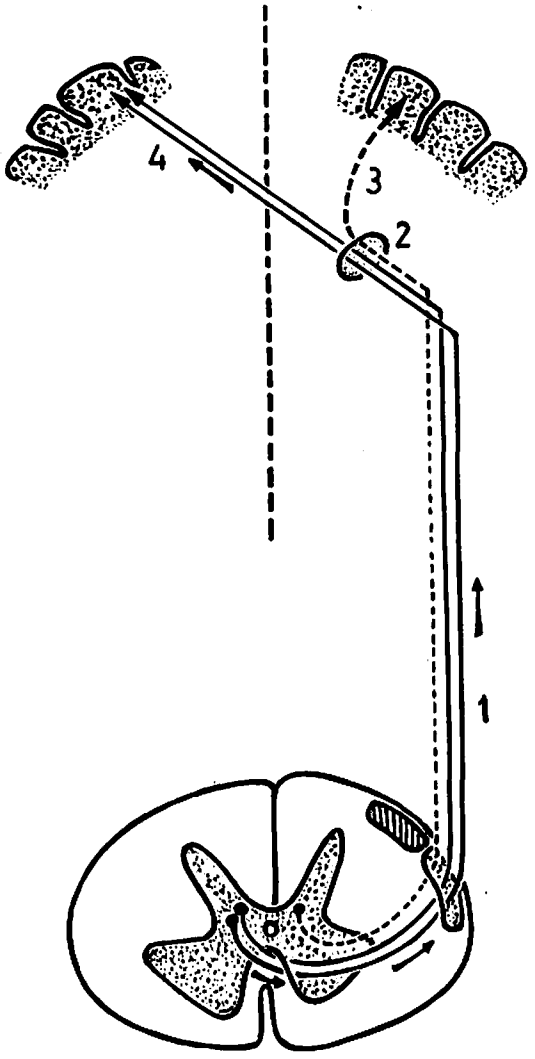


Fig.(44): ANTERIOR SPINOCEREBELLAR TRACT

Its fibres arise from cells at the base of the posterior horn of both sides, mainly of the opposite side. It carries proprioceptive sensations and reaches the cerebellar hemisphere through the superior cerebellar peduncle.

1. anterior spinocerebellar tract.
2. superior cerebellar peduncle.
3. fibres to the cerebellar hemisphere of the same side as their origin.
4. fibres crossing the midline to reach the cerebellar hemisphere of the same side as their origin. (Note that these fibres have crossed the midline in the spinal cord below.)

Fig.(45): DORSOLATERAL TRACT OF LISSAUER

It lies in the lateral funiculus between the tip of the posterior horn and the surface of the cord. It carries pain and temperature, and its fibres are the central processes of cells of the dorsal root ganglia which form the lateral bundle of the dorsal root. As they enter the cord, these fibres ascend for 1-2 segments to relay on cells of the substantia gelatinosa. These ascending fibres form the dorsolateral tract of Lissauer.

1. dorsal root ganglion.
2. dorsolateral tract of Lissauer.
3. substantia gelatinosa.
4. lateral spinothalamic tract.

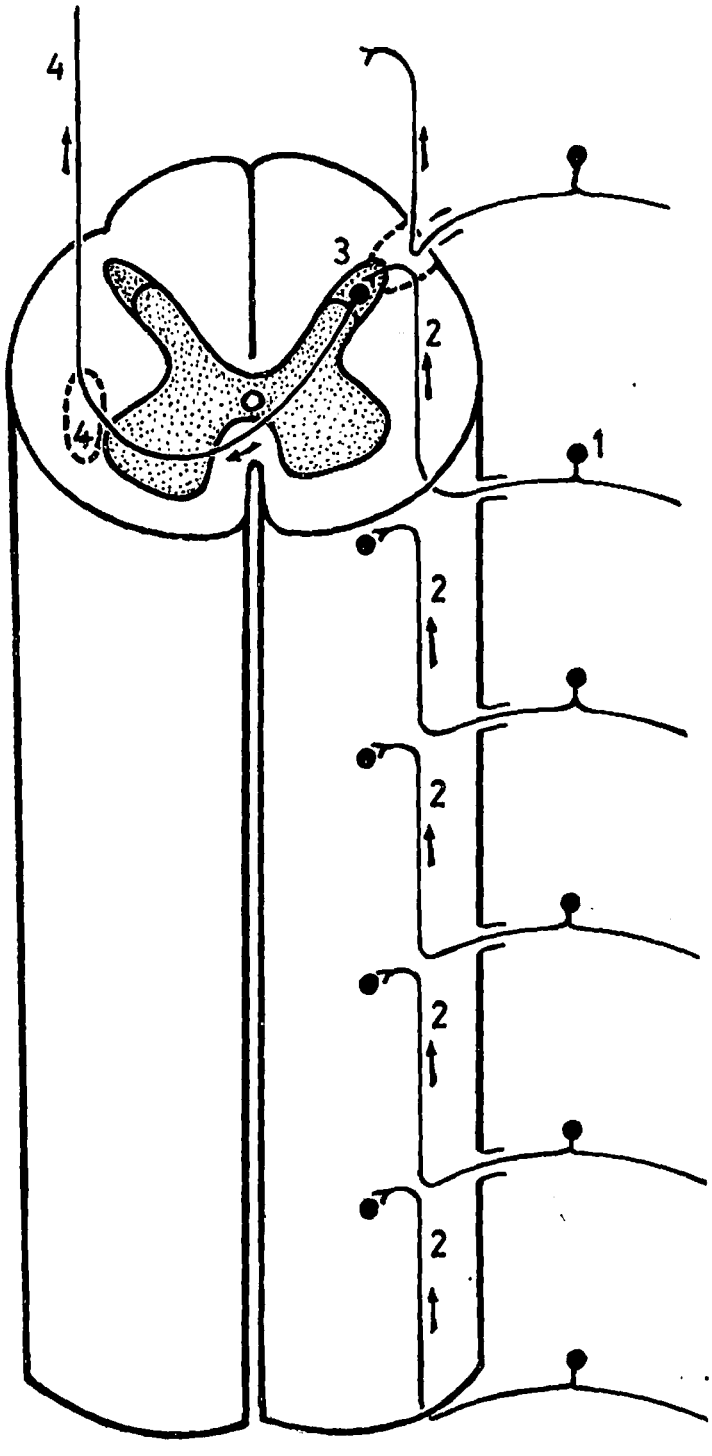


Fig.(46): LATERAL SPINOTHALAMIC TRACT

Its fibres arise from the cells of the substantia gelatinosa and cross the midline in the white commissure in front of the central canal. They ascend in the lateral funiculus to end in the posterolateral ventral nucleus of the thalamus. They carry pain and temperature sensations from the opposite side of the body.

1. substantia gelatinosa.
2. fibres crossing the midline in the white commissure.
3. lateral spinothalamic tract in the lateral funiculus.
4. posterolateral ventral nucleus of thalamus.

* This tract represents the 2nd order neurons on the pathway of pain and temperature. The dorsolateral tract of Lissauer represents the 1st order neurons.

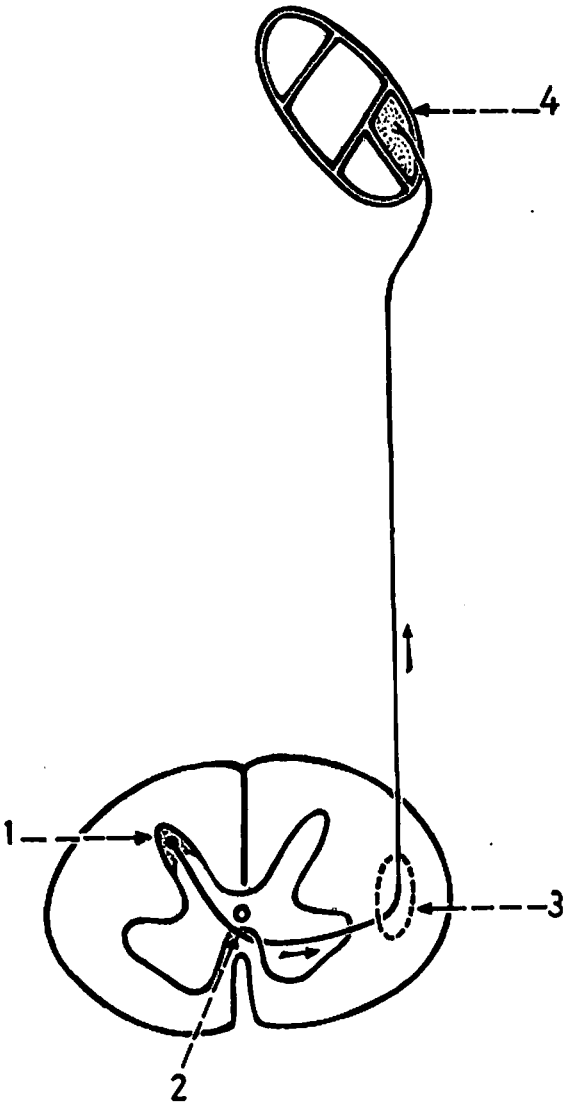


Fig.(47): DECUSSATION OF LATERAL SPINOTHALAMIC TRACTS

This decussation takes place in the white commissure just in front of the central canal of the spinal cord. A lesion here results in destruction of the tracts of both sides as in syringomyelia.

1. substantia gelatinosa.
2. lateral spinothalamic tract.
3. decussation of the tracts of both sides.

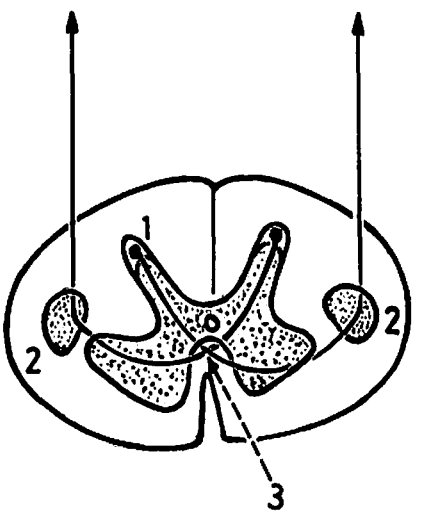


Fig.(48): ANTERIOR (VENTRAL) SPINOTHALAMIC TRACT

Its fibres carry crude touch and pressure sensations from the opposite side of the body. They arise from the cells of the nucleus proprius in the middle of the posterior horn, and cross the midline in the white commissure. This tract ascends in the anterior funiculus and ends above in the posterolateral ventral nucleus of thalamus.

1. dorsal root ganglion.
2. nucleus proprius..
3. fibres of the tract crossing the midline in the white commissure.
4. anterior spinothalamic tract in the anterior funiculus.
5. posterolateral ventral nucleus of thalamus.

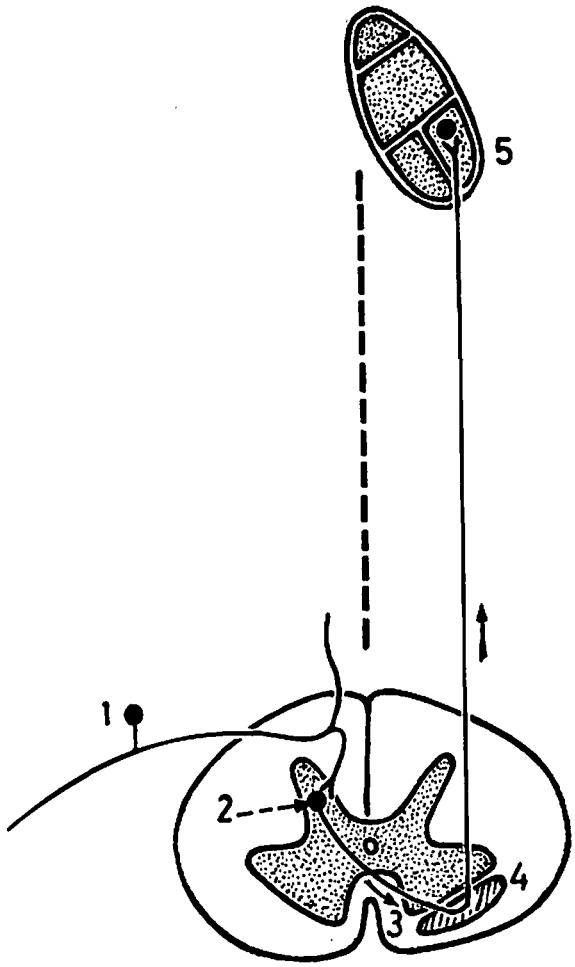
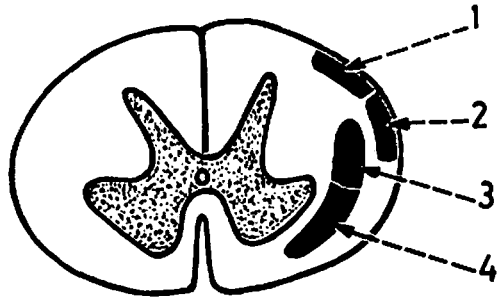


Fig.(49): POSITION OF THE LATERAL AND ANTERIOR SPINOTHALAMIC TRACTS IN THE SPINAL CORD

The lateral spinothalamic tract lies in the lateral funiculus deep to the anterior spinocerebellar tract, while the anterior spinothalamic tract lies close to the anterior horn in the anterior funiculus.

1. posterior spinocerebellar tract.
2. anterior spinocerebellar tract.
3. lateral spinothalamic tract.
4. anterior spinothalamic tract.



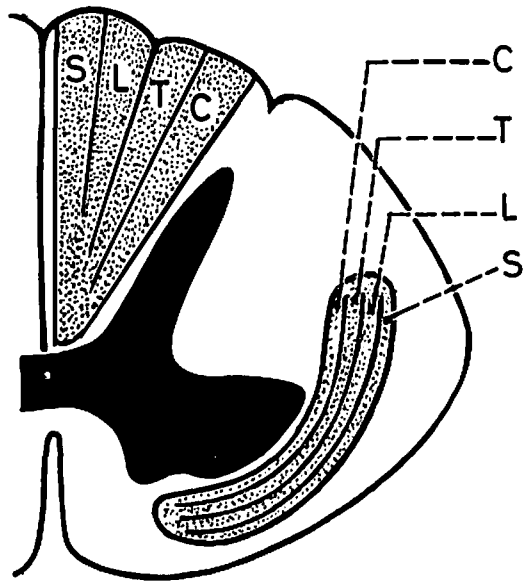


Fig.(50): LAMINATION OF SPINOTHALAMIC TRACTS

The fibres in the lateral and anterior spinothalamic tracts are arranged in laminae so that the sacral fibres are the most superficial, while the cervical fibres are the deepest.

C. cervical fibres.
T. thoracic fibres.
L. lumbar fibres.
S. sacral fibres.

* This arrangement is the reverse of the gracile and cuneate tracts where the cervical fibres are the most lateral, while the sacral fibres are the most medial.

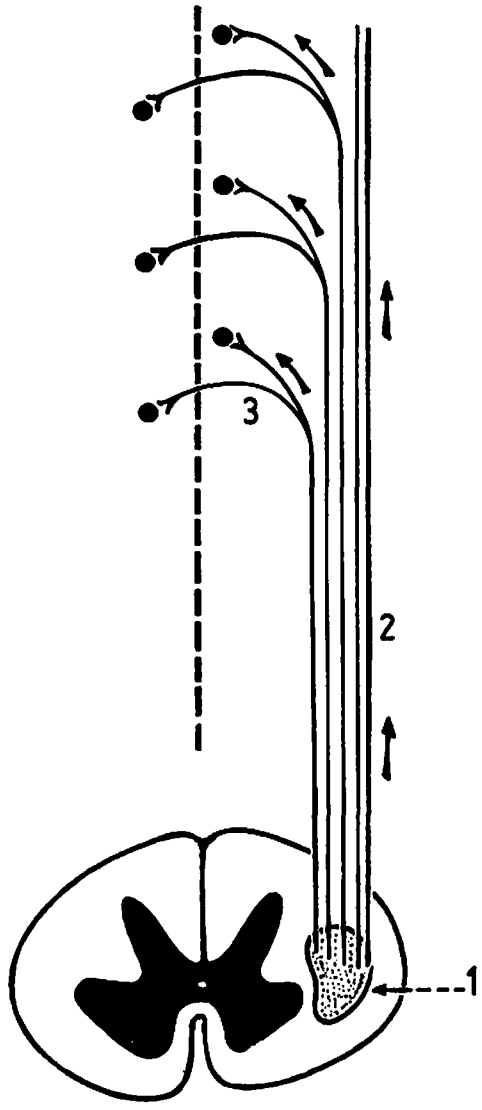


Fig.(51): SPINORETICULAR FIBRES

These fibres ascend in the lateral funiculus not as a separate tract but are intermingled with the spinothalamic fibres. They end on the nuclei of the reticular formation of the brain stem, and carry burning pain.

1. lateral spinothalamic tract.
2. spinoreticular fibres intermingling with the spinothalamic fibres.
3. spinoreticular fibres relaying on nuclei of reticular formation on both sides of the brain stem.

DESCENDING TRACTS IN THE SPINAL CORD

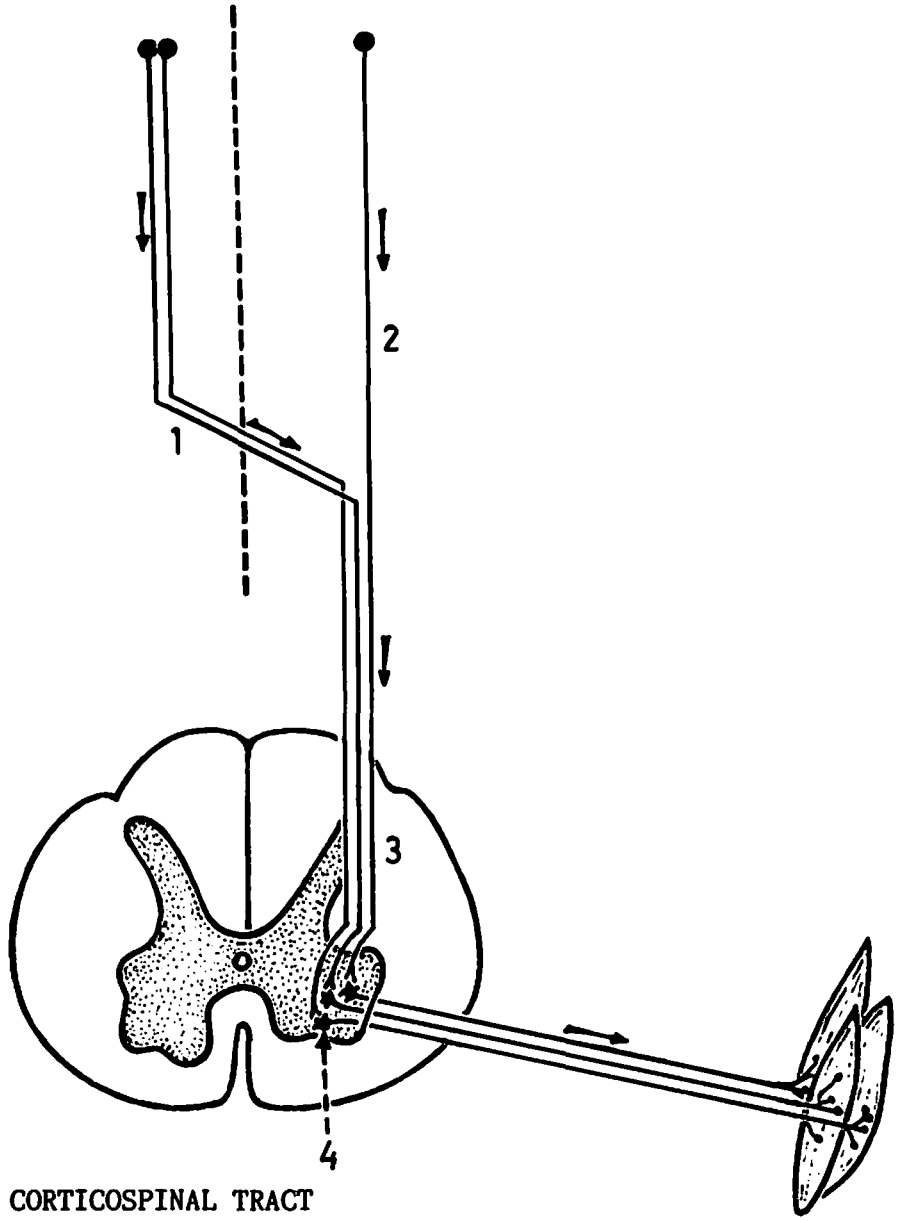


Fig.(52): LATERAL CORTICOSPINAL TRACT

Its fibres arise in the precentral gyrus of the frontal lobe of the cerebral hemisphere (motor area). This tract lies deep in the lateral funiculus and its fibres are mainly derived from the cerebral hemisphere of the opposite side with only few fibres derived from the hemisphere of the same side. They represent the upper motor neurons and relay on the anterior horn cells.

1. corticospinal (pyramidal) fibres crossing the median plane in the motor decussation in the medulla oblongata.
2. uncrossed corticospinal fibres.
3. lateral corticospinal tract (consists mainly of crossed pyramidal fibres together with few uncrossed fibres).
4. anterior horn cells representing the lower motor neurons which end in the skeletal muscle.

Fig.(53): ANTERIOR CORTICOSPINAL TRACT

Its fibres arise in the precentral gyrus of the frontal lobe of the cerebral hemisphere, together with the fibres of the lateral corticospinal tract. These fibres do not cross in the motor decussation and descend in the anterior funiculus of the spinal cord alongside the anterior median fissure. In the cord, these fibres cross the median plane in series to end on the anterior horn cells of the opposite side. This tract does not extend downwards below the midthoracic region.

1. anterior corticospinal tract.
2. fibres crossing the midline in the spinal cord.
3. anterior horn cells representing the lower motor neurons.

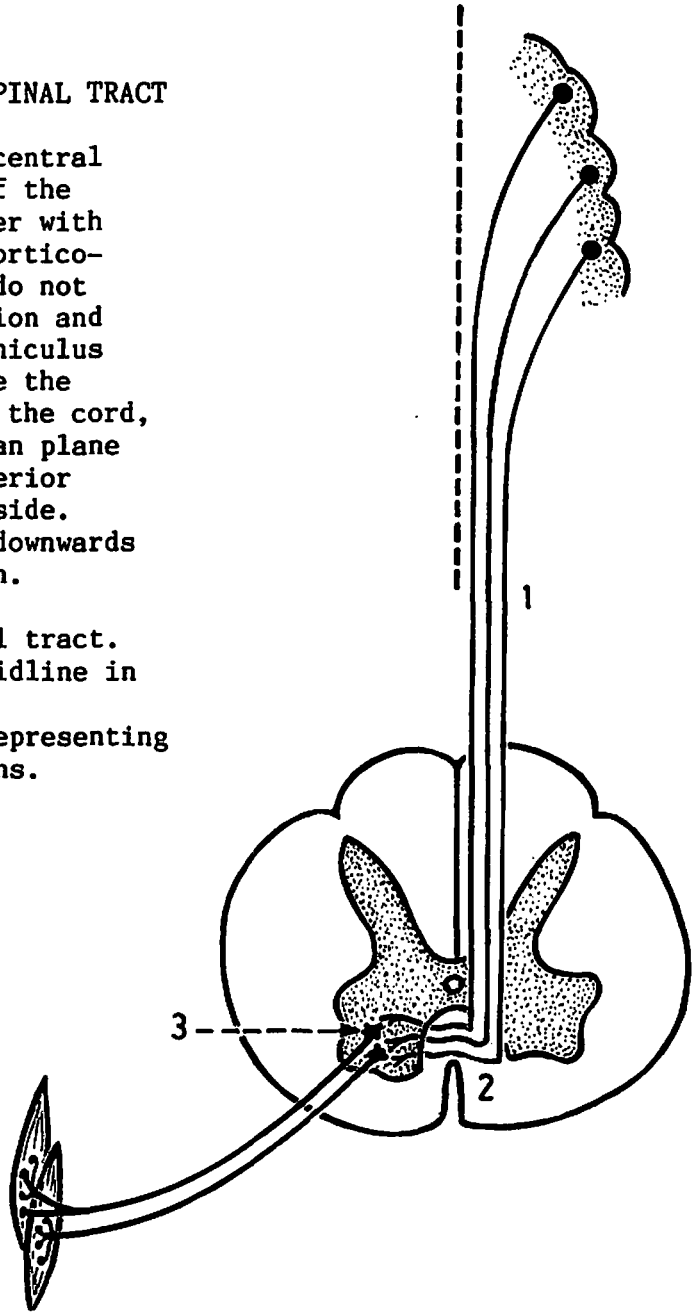
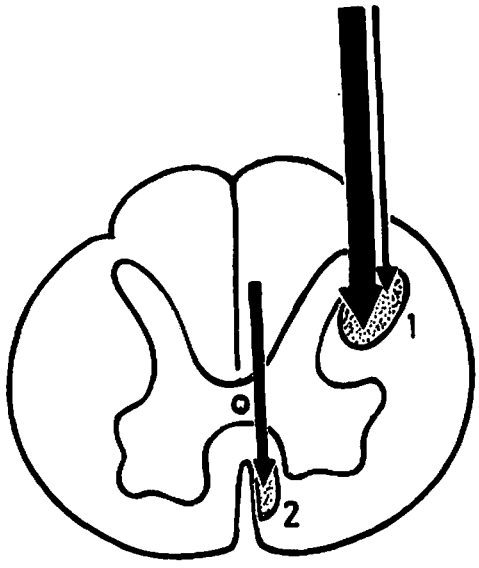
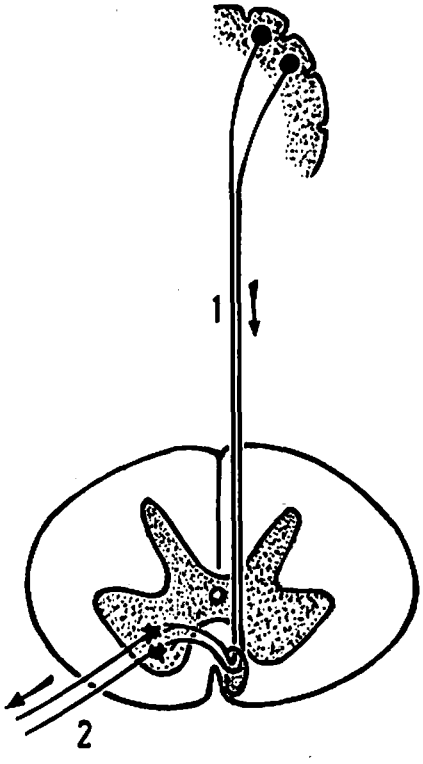


Fig.(54): LATERAL AND ANTERIOR CORTICOSPINAL TRACTS



1. lateral corticospinal tract: lies in the lateral funiculus and consists mainly of crossed pyramidal fibres, in addition to some few uncrossed fibres.
2. anterior corticospinal tract: lies in the anterior funiculus and consists only of uncrossed pyramidal fibres.

Fig.(55): UPPER AND LOWER MOTOR NEURONS



The motor pathway is a descending pathway and consists of upper and lower motor neurons. The upper motor neurons begin in the motor area of the cerebral cortex above, and ends in the brain stem or the spinal cord below; these are represented by the corticonuclear and corticospinal fibres respectively. The lower motor neurons begin in the brain stem or the spinal cord and end in skeletal muscles; these are represented by the motor fibres of the cranial nerves and spinal nerves respectively.

1. upper motor neuron.
2. lower motor neuron.

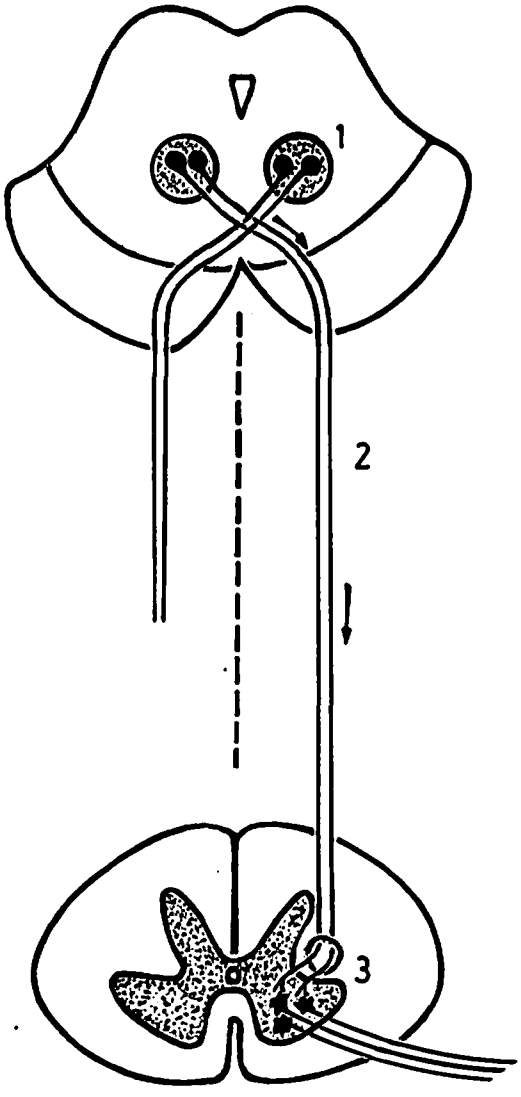


Fig.(56): RUBROSPINAL TRACT

It is a descending pathway which arises from the red nucleus in the midbrain. It crosses to the opposite side and descends in the lateral funiculus of the spinal cord to end on the anterior horn cells.

1. red nucleus.
2. rubrospinal tract.
3. termination of the rubrospinal fibres on the anterior horn cells.

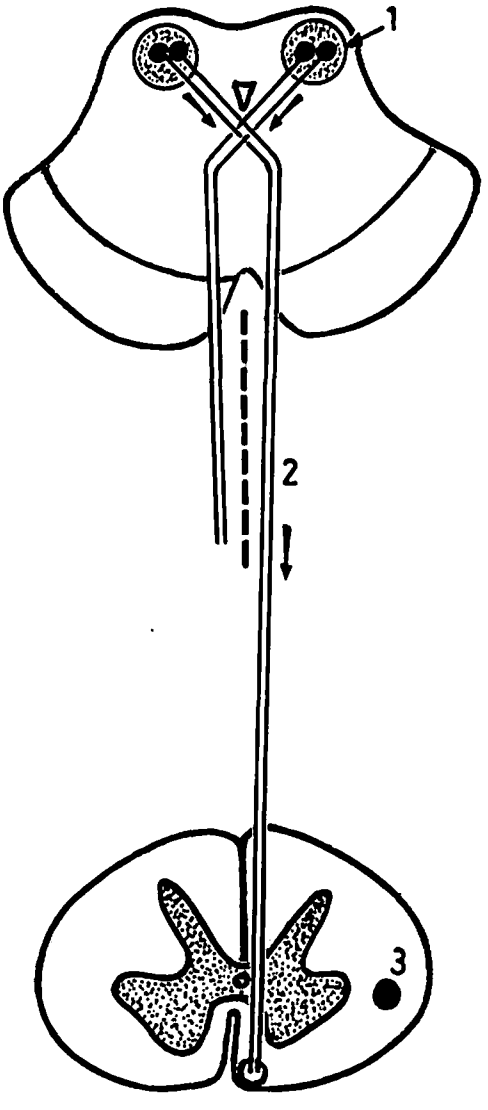


Fig.(57): TECTOSPINAL TRACT

It is a descending tract which arises in the superior colliculus of the tectum of the midbrain. It crosses to the opposite side and descends in the anterior funiculus of the spinal cord to end on the anterior horn cells.

1. superior colliculus.
2. tectospinal tract.
3. spinotectal tract (ascending sensory fibres from the spinal cord to the tectum).

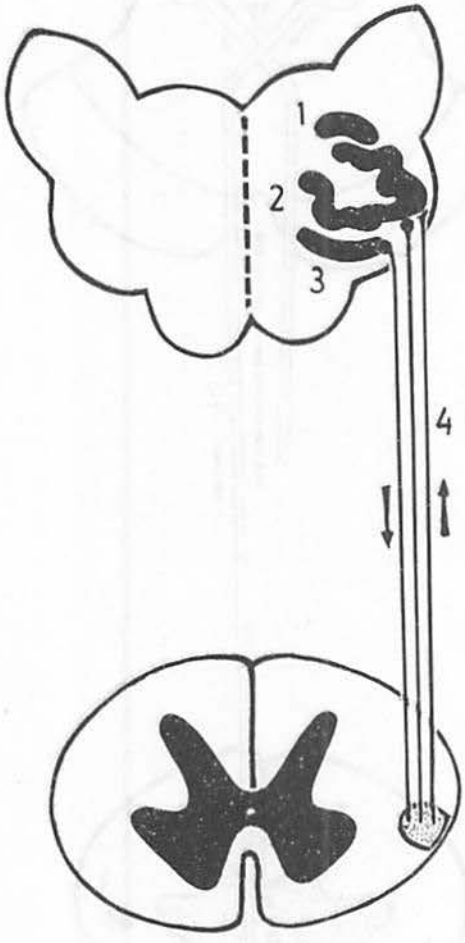


Fig.(58): OLIVOSPINAL AND SPINO-OLIVARY TRACTS

These are descending and ascending fibres intermingling together. They lie in the most ventral part of the lateral funiculus extending between the olivary nuclei and the spinal cord.

1. dorsal accessory olivary nucleus.
2. inferior olivary nucleus.
3. medial accessory olivary nucleus.
4. olivospinal and spino-olivary tracts.

* The olivary nuclei lie in the medulla oblongata.

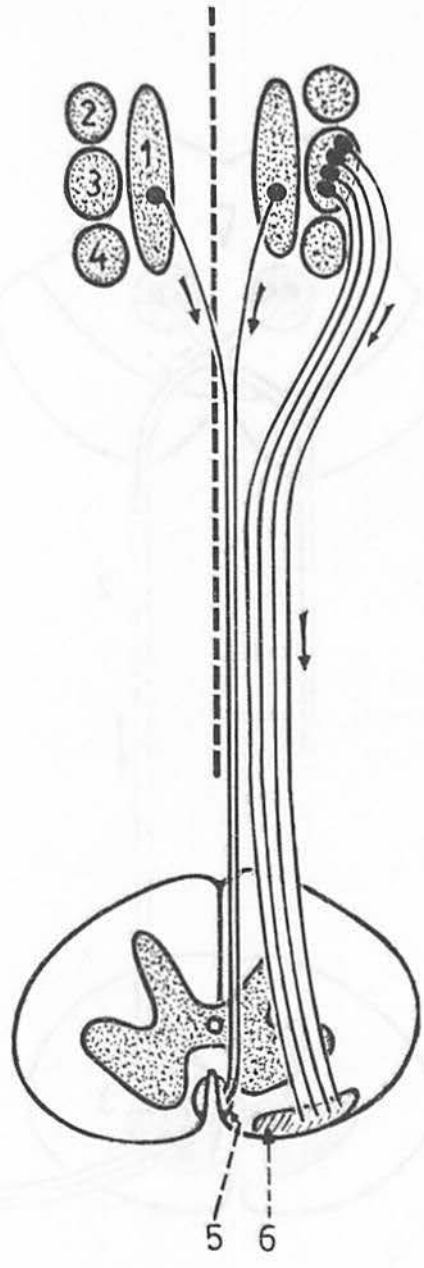


Fig.(59): LATERAL AND MEDIAL VESTIBULOSPINAL TRACTS

The lateral vestibulospinal tract arises from the lateral vestibular nucleus of the same side, while the medial vestibulospinal tract arises from the medial vestibular nuclei of both sides.

1. medial vestibular nucleus.
2. superior vestibular nucleus.
3. lateral vestibular nucleus.
4. inferior vestibular nucleus.
5. medial vestibulospinal tract.
6. lateral vestibulospinal tract.

Fig.(60): LATERAL RETICULOSPINAL TRACT

It arises from the reticular nucleus of the reticular formation in the medulla oblongata. Its fibres are mainly crossed fibres and descend in the lateral funiculus of the spinal cord.

1. reticular nucleus.
2. lateral reticulospinal tract.

* The medial reticulospinal tract arises from the pontine reticular nuclei of the same side and descends in the anterior funiculus where it intermingles with the anterior spinothalamic tract.

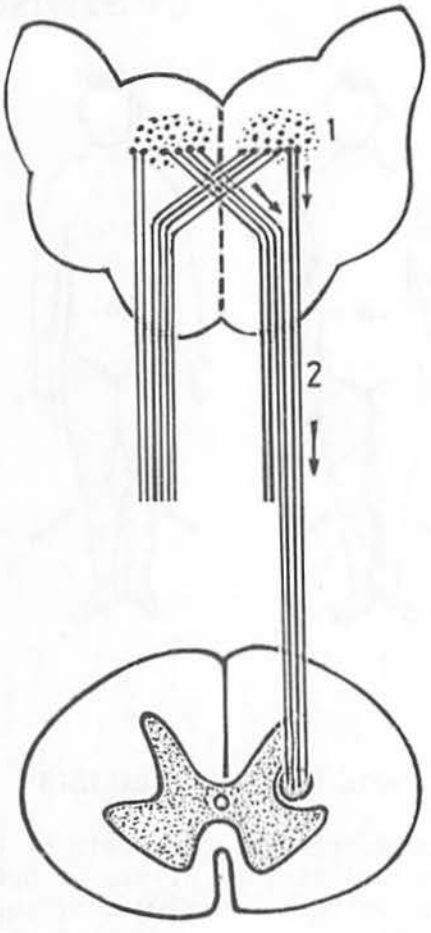
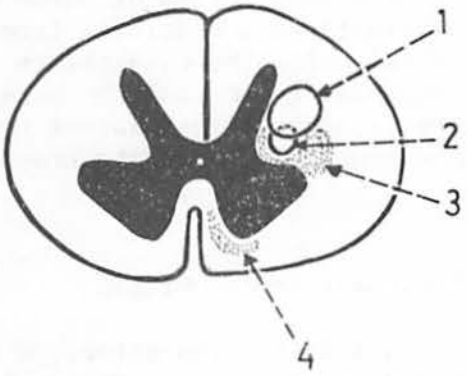


Fig.(61): DESCENDING AUTONOMIC FIBRES

These fibres arise from the higher autonomic centres, and descend as dispersed fibres in the lateral and anterior funiculi of the spinal cord. They end on the autonomic cells in the lateral horn of the spinal cord.

1. lateral corticospinal tract.
2. rubrospinal tract.
3. descending autonomic fibres in the lateral funiculus.
4. descending autonomic fibres in the anterior funiculus.



LESIONS OF SPINAL CORD

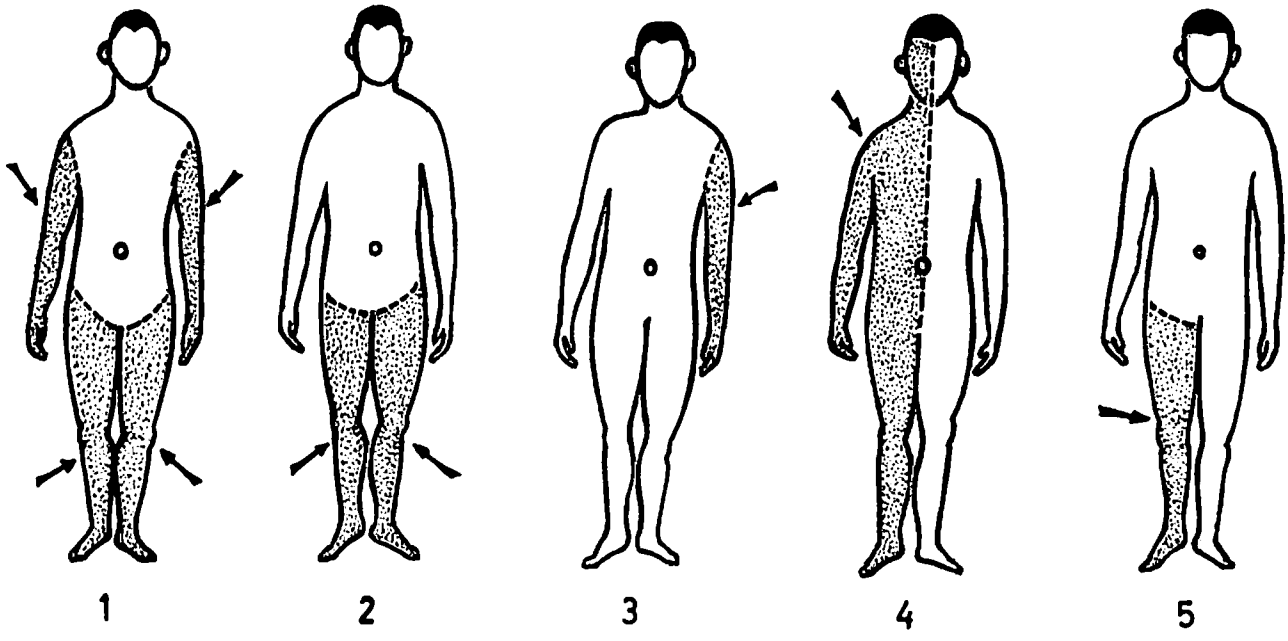


Fig.(62): TYPES OF PARALYSIS

1. quadriplegia: paralysis of both upper limbs and both lower limbs.
2. paraplegia: paralysis of both lower limbs.
3. monoplegia: paralysis of one upper limb.
4. hemiplegia: paralysis of the right or the left 1/2 of the body.
5. monoplegia: paralysis of one lower limb.

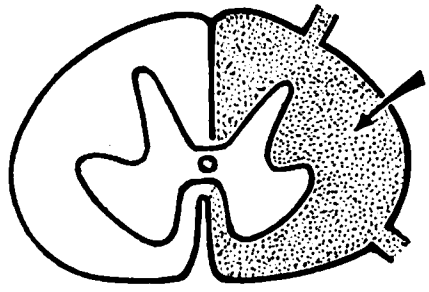


Fig.(63): BROWN-SEQUARD SYNDROME

It is a combination of motor and sensory manifestations resulting from hemisection of the spinal cord. The main tracts which produce clinical symptoms are lateral and anterior corticospinal tracts, lateral and anterior spinothalamic tracts, and gracile and cuneate tracts.

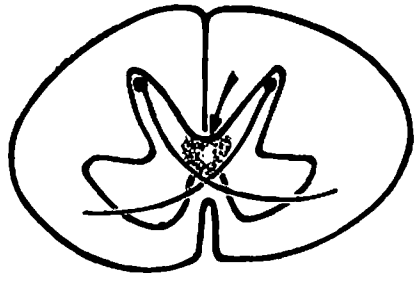
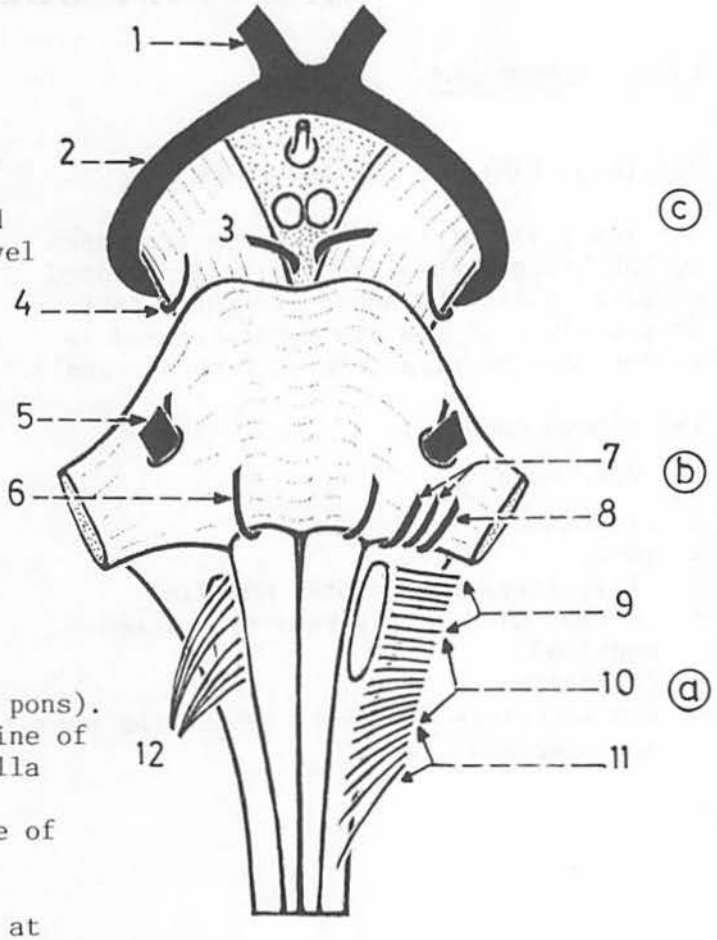


Fig.(64); SYRINGOMYELIA

It is a lesion characterised by degenerative widening of the central canal of the spinal cord (arrow). As a result, the decussating fibres of the lateral spinothalamic tracts will be interrupted leading to loss of pain and temperature sensations in the affected segments on both sides of the body.

Fig.(65): ANTERIOR ASPECT OF BRAINSTEM



The brain stem consists of the medulla oblongata, pons and midbrain, from below upwards. It is continuous above with the base of the brain, and below with the spinal cord at the level of the foramen magnum.

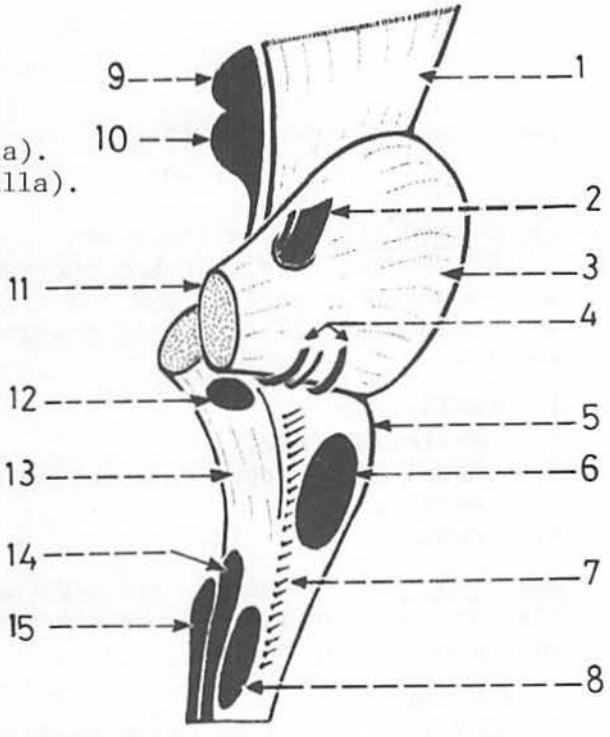
(a) medulla oblongata.

(b) pons.

(c) midbrain.

1. optic nerve.
2. optic tract.
3. oculomotor nerve (attached to the midbrain).
4. trochlear nerve (attached to the midbrain).
5. trigeminal nerve (attached to the pons).
6. abducent nerve (attached at the line of junction between the pons and medulla oblongata).
7. facial nerve (attached at the line of junction between the pons and medulla oblongata).
8. vestibulocochlear nerve (attached at the line of junction between the pons and medulla oblongata).
9. glossopharyngeal nerve (attached to the medulla oblongata).
10. vagus nerve (attached to the medulla).
11. accessory nerve (attached to the medulla).
12. hypoglossal nerve (attached to the medulla).

Fig.(66): LATERAL ASPECT OF BRAINSTEM



1. midbrain.
2. trigeminal nerve.
3. basilar part of the pons.
4. facial and vestibulocochlear nerves.
5. pyramid of medulla oblongata.
6. olive.
7. posterolateral sulcus of the medulla.
8. tuberculum cinereum.
9. superior colliculus.
10. inferior colliculus.
11. middle cerebellar peduncle.
12. ventral cochlear nucleus.
13. inferior cerebellar peduncle.
14. cuneate tubercle.
15. gracile tubercle.

MEDULLA OBLONGATA

GROSS MORPHOLOGY

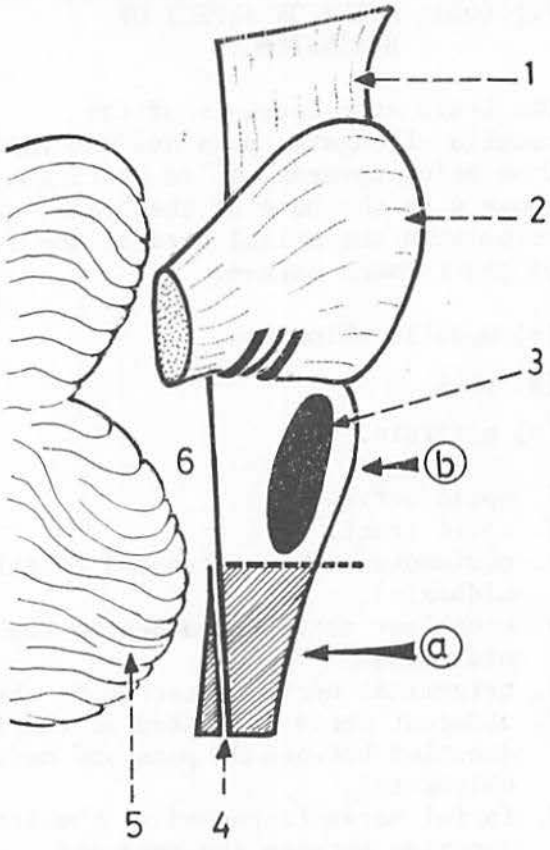


Fig.(67): PARTS OF MEDULLA OBLONGATA

The lower 1/2 of the medulla is traversed by the central canal and is called closed medulla, while the upper 1/2 forms part of the floor of the 4th ventricle and is called open medulla (has no central canal).

(a) closed medulla.

(b) open medulla.

1. midbrain.
2. pons.
3. olive (lies in the open medulla).
4. central canal (traverses the closed medulla).
5. cerebellum.
6. 4th ventricle (a cavity behind the pons and open medulla).

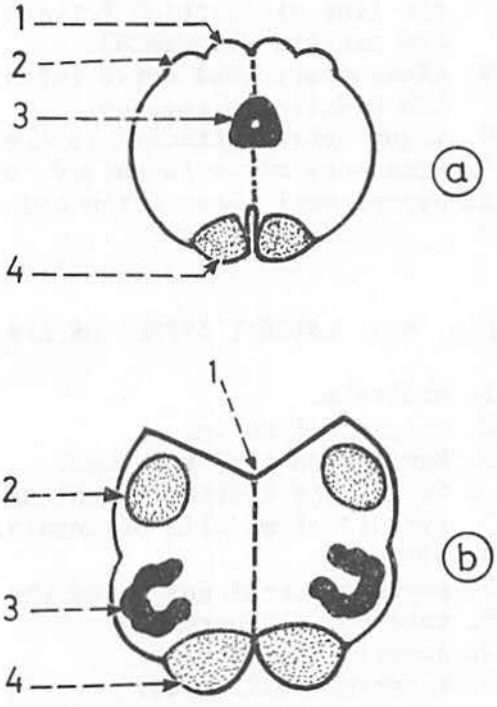


Fig.(68): CLOSED AND OPEN MEDULLA (transverse section)

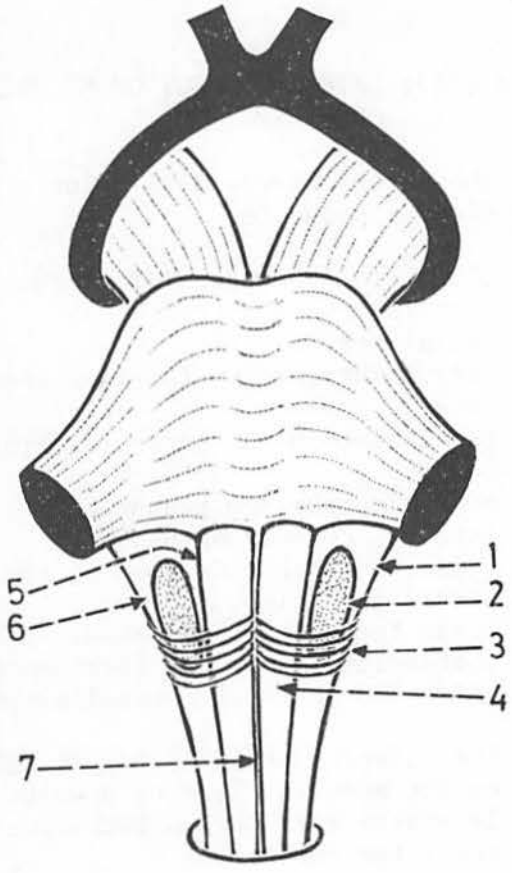
(a) Closed medulla: it is traversed by the central canal. It has the pyramids on its anterior surface and the gracile and cuneate tubercles on its posterior surface.

1. gracile tubercle.
2. cuneate tubercle.
3. central grey matter surrounding the central canal.
4. pyramid.

(b) Open medulla: it has the pyramids on its anterior surface and the 4th ventricle on its posterior surface.

1. 4th ventricle.
2. inferior cerebellar peduncle.
3. olive.
4. pyramid.

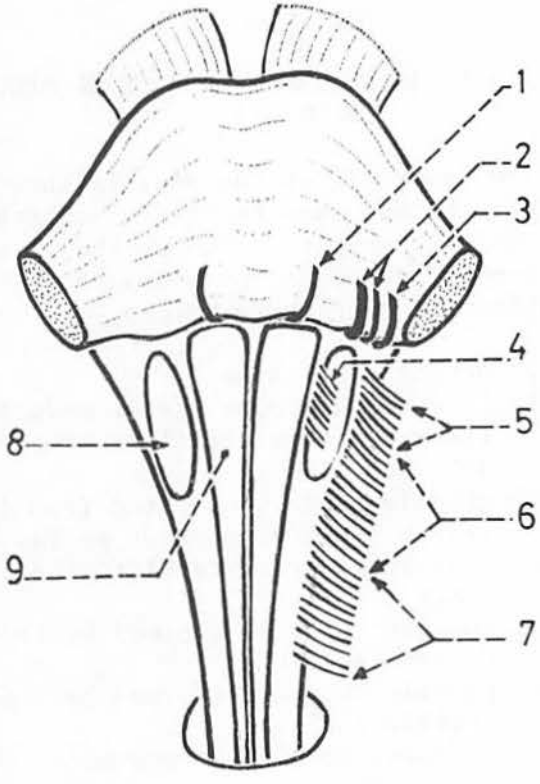
Fig.(69): ELEVATIONS ON THE ANTEROLATERAL SURFACE OF THE MEDULLA OBLONGATA



These are the pyramid, olive and inferior cerebellar peduncle (on each side). The pyramid is the most medial elevation and is separated from its fellow by the anterior median fissure. The olive lies lateral to the pyramid and is separated from it by the anterolateral sulcus. The inferior cerebellar peduncle lies behind the olive and is separated from it by the posterolateral sulcus.

1. inferior cerebellar peduncle.
2. olive (formed by the inferior olivary nucleus).
3. anterior external arcuate fibres (cross over the surface of the olive).
4. pyramid (consists of corticospinal fibres).
5. anterolateral sulcus (between the olive and pyramid).
6. posterolateral sulcus (between the olive and inferior cerebellar peduncle).
7. anterior median fissure (between the 2 pyramids).

Fig.(70): NERVES ATTACHED TO THE ANTEROLATERAL SURFACE OF THE MEDULLA OBLONGATA



These nerves are attached as follows: 6th, 7th and 8th nerves at the line of junction between the pons and medulla, 9th, 10th and 11th nerves to the posterolateral sulcus, while the 12th nerve to the anterolateral sulcus.

1. abducent nerve (above the pyramid).
2. facial nerve (at the upper end of the posterolateral sulcus).
3. vestibulocochlear nerve (just lateral to the facial nerve).
4. hypoglossal nerve (in the anterolateral sulcus).
5. glossopharyngeal nerve (in the posterolateral sulcus).
6. vagus nerve (below the glossopharyngeal).
7. accessory nerve (below the vagus).
8. olive.
9. pyramid.

Fig.(71): LATERAL ASPECT OF MEDULLA OBLONGATA

It shows the olive and inferior cerebellar peduncle.

1. olive (in the upper 1/2 of the medulla).
2. facial nerve.
3. nervus intermedius (part of facial nerve).
4. vestibulocochlear nerve (auditory nerve).
5. middle cerebellar peduncle.
6. inferior cerebellar peduncle (directed backwards deep to the middle peduncle).
7. ridge formed by the cochlear nuclei.
8. posterolateral sulcus (between the olive and inferior cerebellar peduncle).

* The inferior peduncle begins half-way up the medulla. It runs upwards and laterally then curves backwards to enter the cerebellum.

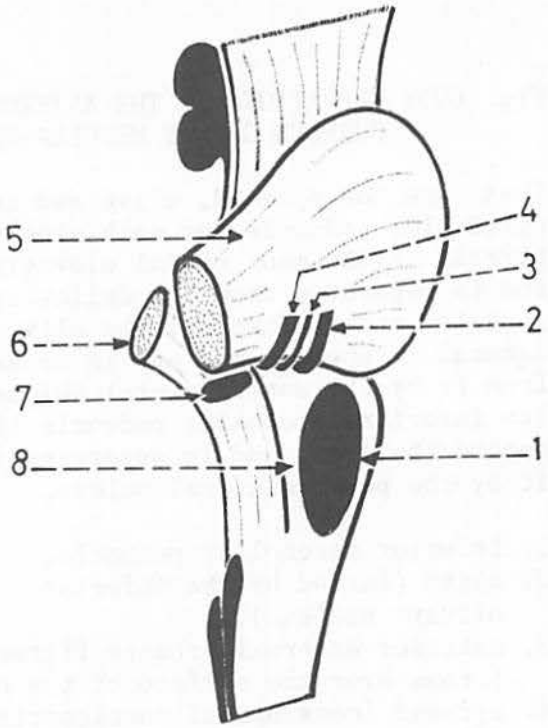
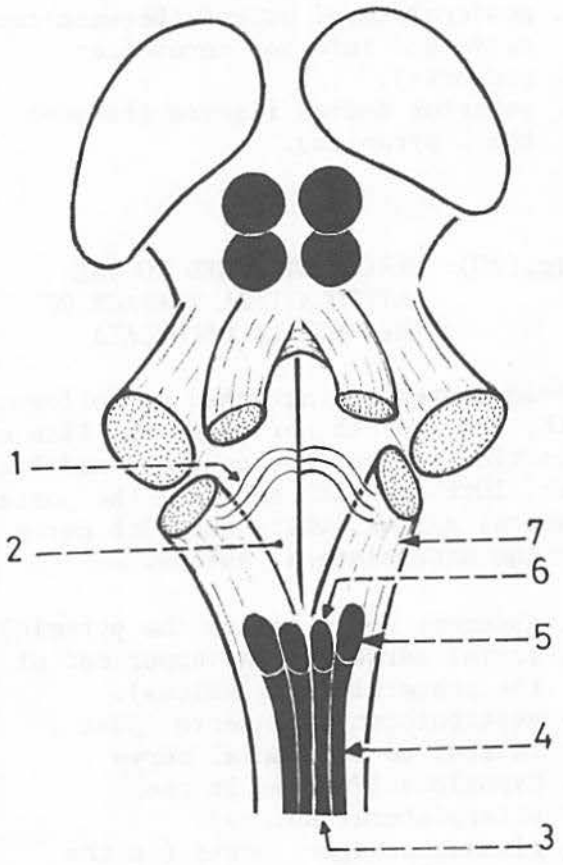


Fig.(72): POSTERIOR ASPECT OF MEDULLA OBLONGATA

The lower 1/2 of the medulla shows the gracile and cuneate tracts and tubercles, while its upper 1/2 shows the inferior cerebellar peduncles and part of the floor of the 4th ventricle.

1. striae medullares.
2. back of the upper 1/2 of medulla (forms part of the floor of the 4th ventricle).
3. gracile tract (separated from its fellow by the posterior median sulcus).
4. cuneate tract (lateral to the gracile tract).
5. cuneate tubercle (formed by the cuneate nucleus).
6. gracile tubercle (formed by the gracile nucleus).
7. inferior cerebellar peduncle.



INTERNAL STRUCTURE OF MEDULLA OBLONGATA

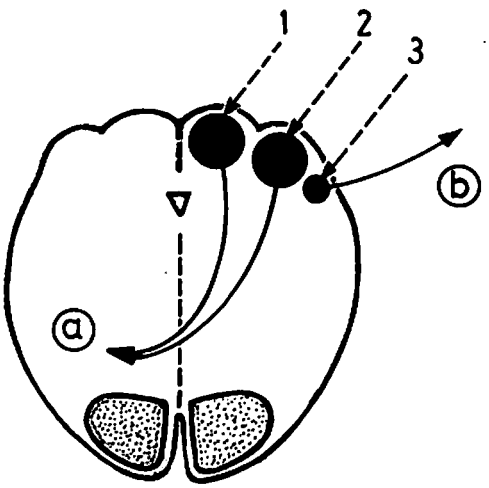


Fig.(73): GRACILE AND CUNEATE NUCLEI

They form the gracile and cuneate tubercles which lie on the back of the medulla at its middle. They form the 2nd order neurons of proprioception and fine touch.

1. gracile nucleus.
2. cuneate nucleus.
3. accessory cuneate nucleus (lateral to the cuneate).

(a) 2nd order neurons from the gracile and cuneate nuclei on their way to the cerebrum.
(b) 2nd order neurons from the accessory cuneate nucleus on their way to the cerebellum.

* The gracile and cuneate nuclei lie in the closed medulla.

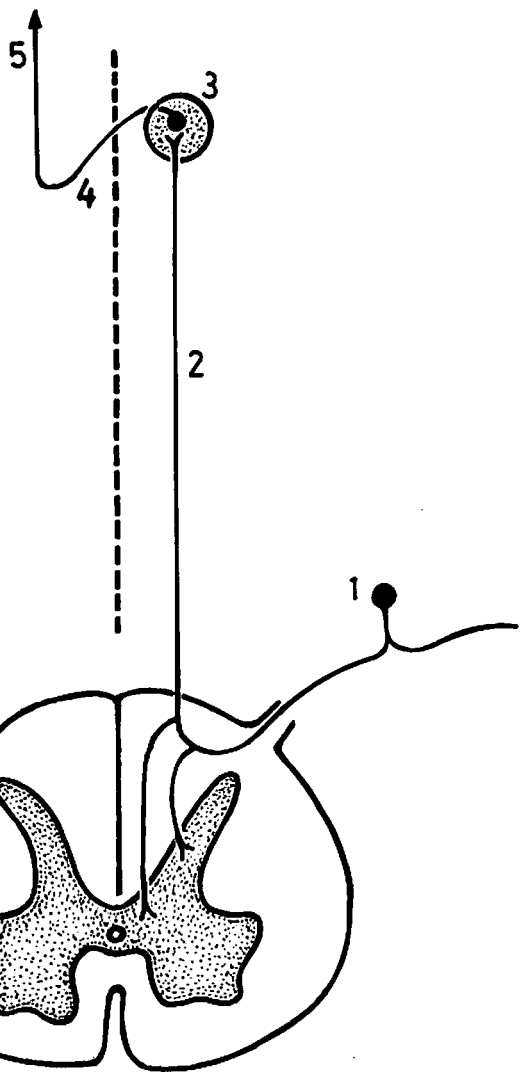


Fig.(74): GRACILE NUCLEUS AND TRACT

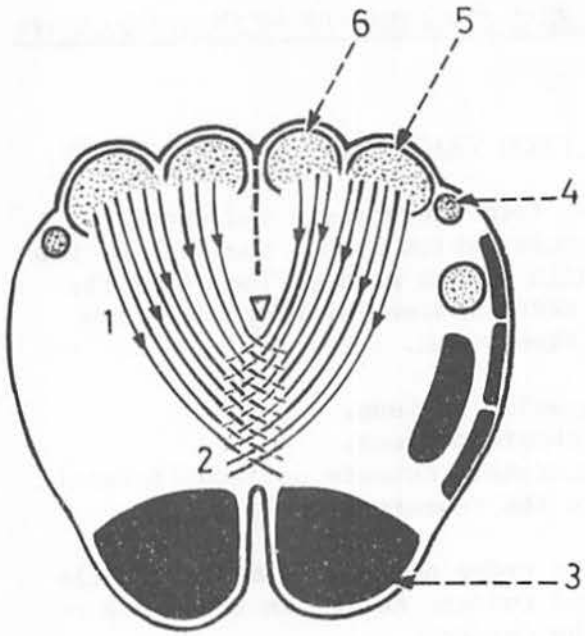
The gracile nucleus receives the terminations of the fibres of the gracile tract which form the 1st order neurons of proprioception and fine touch.

1. dorsal root ganglion.
2. gracile tract.
3. gracile nucleus.
4. internal arcuate fibres (cross the midline in the sensory decussation).
5. medial lemniscus (ascends to the thalamus).

* Similar to the gracile nucleus, the cuneate nucleus receives the cuneate tract.

* The accessory cuneate nucleus (fig.73) receives the most lateral fibres of the cuneate tract.

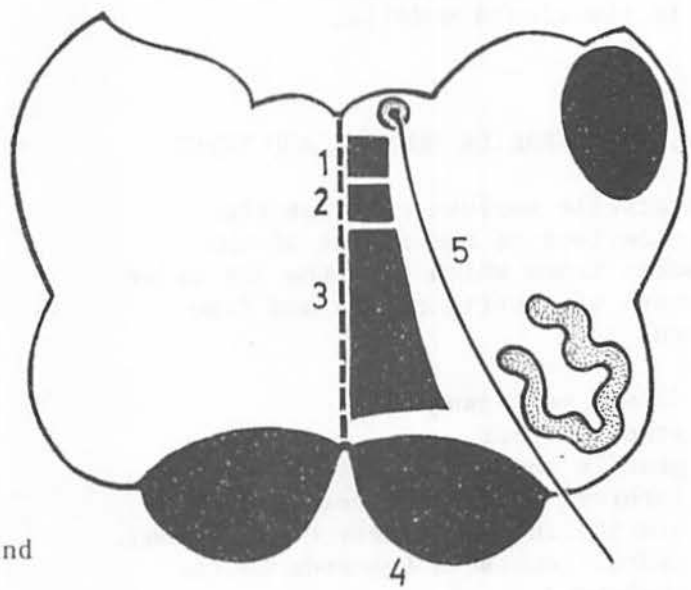
Fig.(75): SENSORY DECUSSATION
(decussation of lemnisci)



The gracile and cuneate nuclei give rise to the internal arcuate fibres which cross the midline of the upper part of the closed medulla forming the sensory decussation.

1. internal arcuate fibres.
2. sensory decussation (just behind the pyramids).
3. pyramid (corticospinal fibres).
4. accessory cuneate nucleus.
5. cuneate nucleus.
6. gracile nucleus.

Fig.(76): MEDIAL LEMNISCUS IN
THE OPEN MEDULLA



After crossing the midline in the sensory decussation, the internal arcuate fibres ascend adjacent to the midline in the form of a flattened band called medial lemniscus.

1. medial longitudinal bundle.
2. tectospinal tract.
3. medial lemniscus (lies alongside the median plane, just behind the pyramid).
4. pyramid.
5. fibres of hypoglossal nerve (lateral to the medial lemniscus).

* The medial lemniscus carries proprioception and fine touch from the opposite side of the body below the head.

Fig.(77): ARRANGEMENT OF THE FIBRES OF MEDIAL LEMNISCUS

In the medulla oblongata, the medial lemniscus forms an anteroposterior band with the cervical fibres most posterior and the sacral fibres most anterior. However, in the pons the medial lemniscus forms a transverse band with the cervical fibres most medial and the sacral fibres most lateral.

1. medial lemniscus in the open medulla.
2. medial lemniscus in the pons.

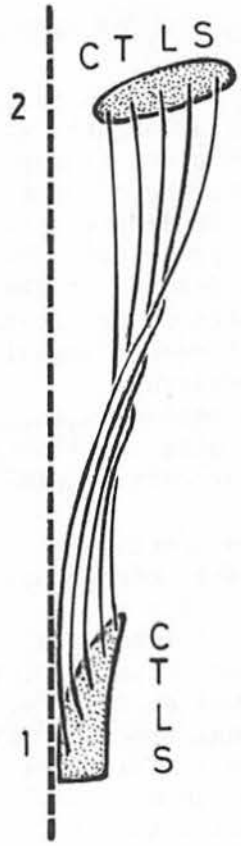


Fig.(78): POSITION OF THE MEDIAL LEMNISCUS IN THE PONS

The medial lemniscus forms a transverse band close to the midline, in the most anterior part of the tegmentum.

1. basilar part of the pons.
2. medial lemniscus.
3. tegmentum of the pons.

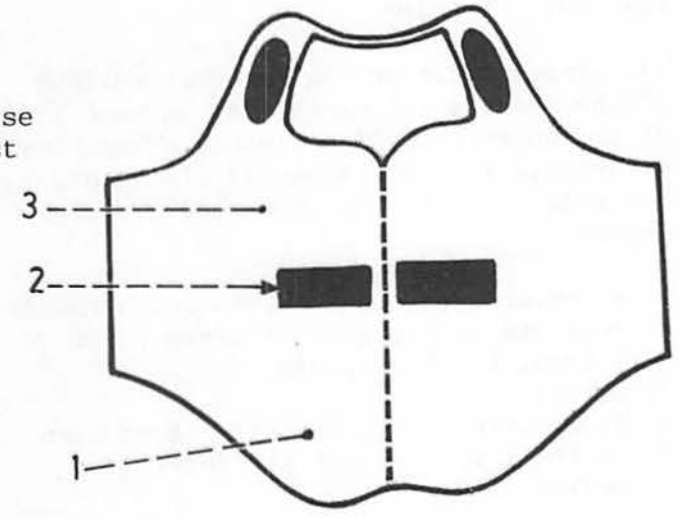
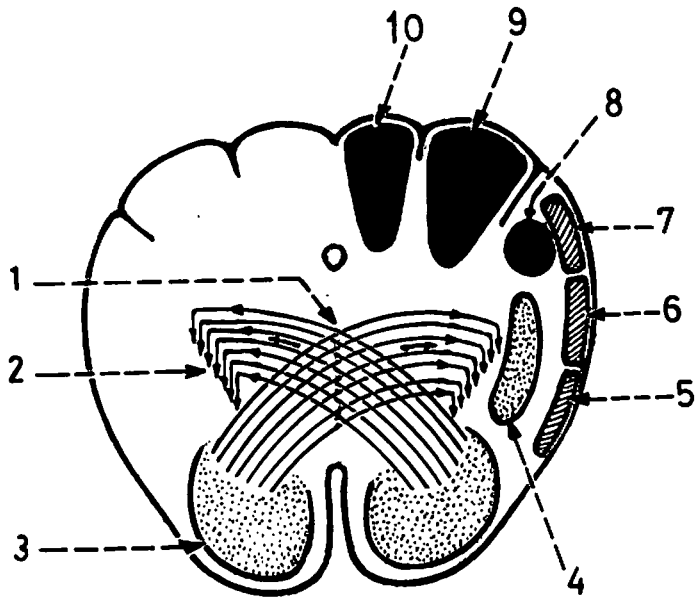


Fig.(79): MOTOR DECUSSATION

In the lowermost part of the medulla oblongata, 75% - 85% of the corticospinal fibres in the pyramid cross to the opposite side forming the motor decussation (decussation of the pyramids). The crossed fibres descend in the lateral funiculus of the spinal cord as the lateral corticospinal tract. The remaining 15% - 25% of the fibres descend without crossing in the anterior funiculus as the anterior corticospinal tract.

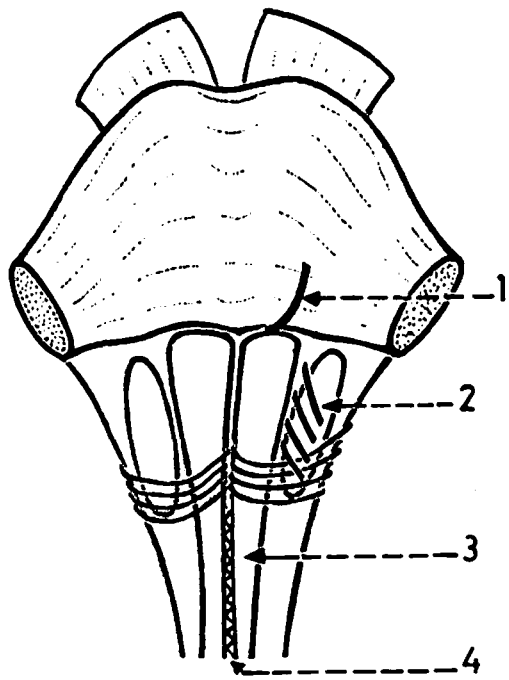


1. motor decussation.
2. lateral corticospinal tract.
3. pyramid.
4. spinal lemniscus.
5. anterior spinocerebellar tract.
6. posterior spinocerebellar tract.
7. spinal tract of trigeminal nerve.
8. spinal nucleus of trigeminal nerve.
9. cuneate nucleus.
10. gracile nucleus.

* The motor decussation lies at a lower level than the sensory decussation, and both decussations are situated in the closed medulla.

Fig.(80): PYRAMIDS

The pyramids lie on the anterior surface of the medulla oblongata, one on each side of the anterior median fissure. They consist of pyramidal (corticospinal) fibres and are related to the abducent and hypoglossal nerves.



1. abducent nerve (just above the pyramid).
2. rootlets of hypoglossal nerve (just lateral to the pyramid).
3. pyramid.
4. decussating corticospinal fibres seen in the lower part of the anterior median fissure.

Fig.(81): ARRANGEMENT OF CORTICOSPINAL FIBRES IN THE MEDULLA OBLONGATA AND SPINAL CORD

In the medulla oblongata, the corticospinal fibres descend in the pyramids. 75% - 85% of these fibres cross in the motor decussation, while the remaining 15% - 25% do not cross. In the spinal cord the crossed fibres descend in the lateral funiculus as the lateral corticospinal tract, while the uncrossed fibres descend in the anterior funiculus as the anterior corticospinal tract.

1. corticospinal fibres above the level of decussation.
2. few fibres descending within the lateral corticospinal tract without crossing.
3. motor decussation in the closed medulla.
4. lateral corticospinal tract (most of its fibres are crossed with only few fibres uncrossed).
5. anterior corticospinal tract (its fibres are uncrossed, but they cross at various segments of the spinal cord).

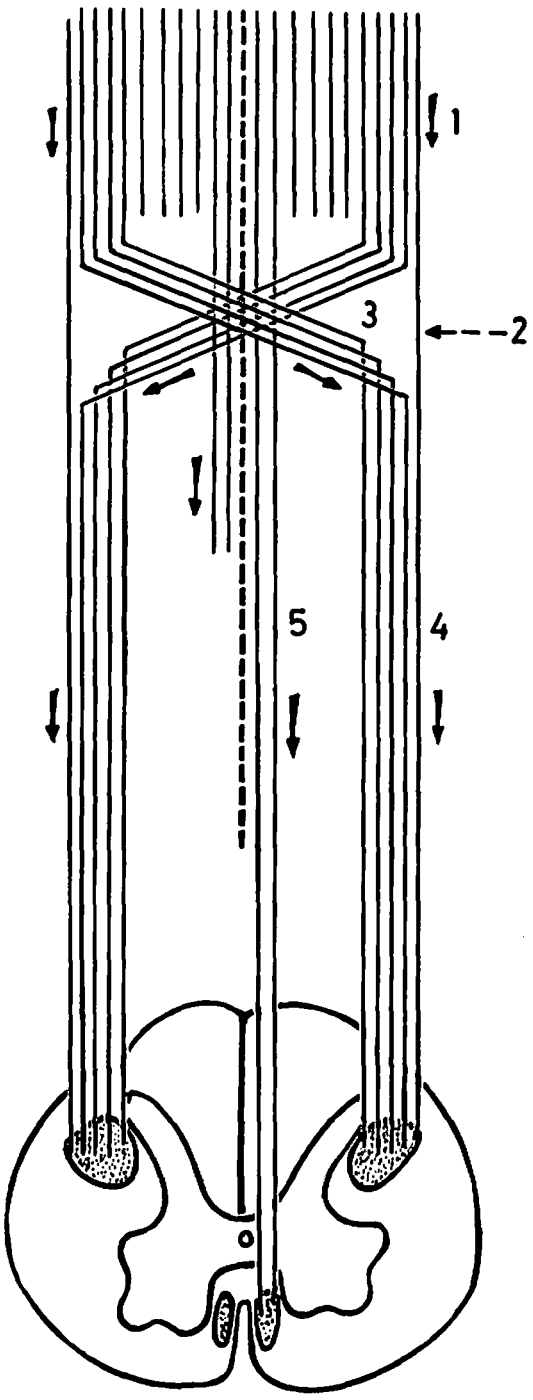
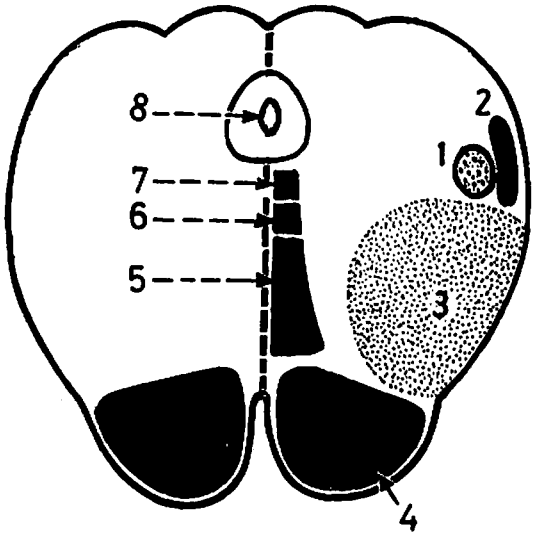


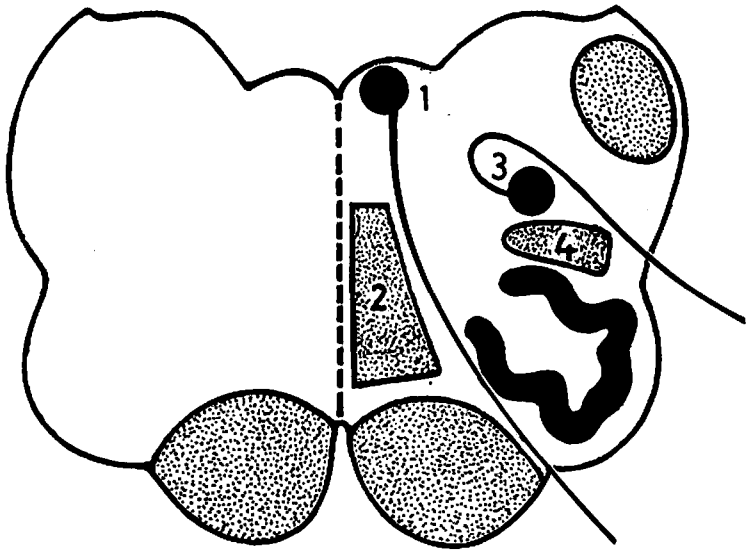
Fig.(82): ARRANGEMENT OF TRACTS IN THE MEDULLA OBLONGATA



The tracts in the medial part of the medulla oblongata lie close to the midline, and are arranged from before backwards as follows: pyramid, medial lemniscus, spinotectal tract and medial longitudinal bundle.
The tracts in the lateral part of the medulla are mainly the upward continuation of the tracts of the spinal cord (spinothalamic and spinocerebellar tracts), in addition to the spinal tract of trigeminal nerve.

1. spinal nucleus of trigeminal nerve.
2. spinal tract of trigeminal nerve (lateral to its nucleus).
3. anterolateral part of the medulla containing the spinothalamic and spinocerebellar tracts.
4. pyramidal tract.
5. medial lemniscus.
6. tectospinal tract.
7. medial longitudinal bundle.
8. central canal of the closed medulla.

Fig.(83): ARRANGEMENT OF MOTOR NUCLEI IN THE MEDULLA OBLONGATA

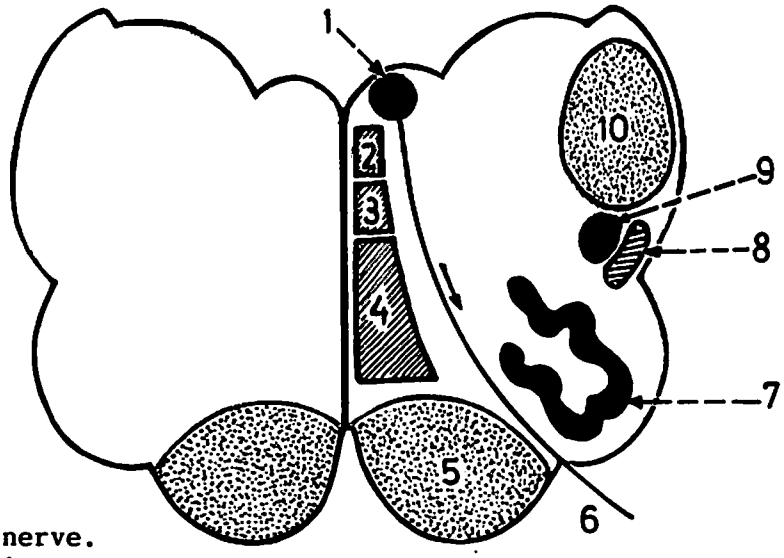


The only motor nuclei of cranial nerves in the medulla oblongata are the hypoglossal nucleus and the nucleus ambiguus which serves the 9th, 10th and 11th cranial nerves. The hypoglossal nucleus lies in the medial part of the medulla, while the nucleus ambiguus lies in its lateral part.

1. hypoglossal nucleus (in the floor of the 4th ventricle close to the midline).
2. medial lemniscus (close to the emerging fibres of the hypoglossal nerve).
3. nucleus ambiguus.
4. spinal lemniscus (combined anterior and lateral spinothalamic tracts).

Fig.(84): HYPOGLOSSAL NUCLEUS

It lies in the most posterior part of the medulla close to the midline. Its fibres pass forwards and laterally close to the medial lemniscus, and emerge on the surface between the pyramid and olive.



1. hypoglossal nucleus.
2. medial longitudinal bundle.
3. tectospinal tract.
4. medial lemniscus.
5. pyramid.
6. emerging fibres of hypoglossal nerve.
7. inferior olivary nucleus.
8. spinal tract of trigeminal nerve.
9. spinal nucleus of trigeminal nerve.
10. inferior cerebellar peduncle.

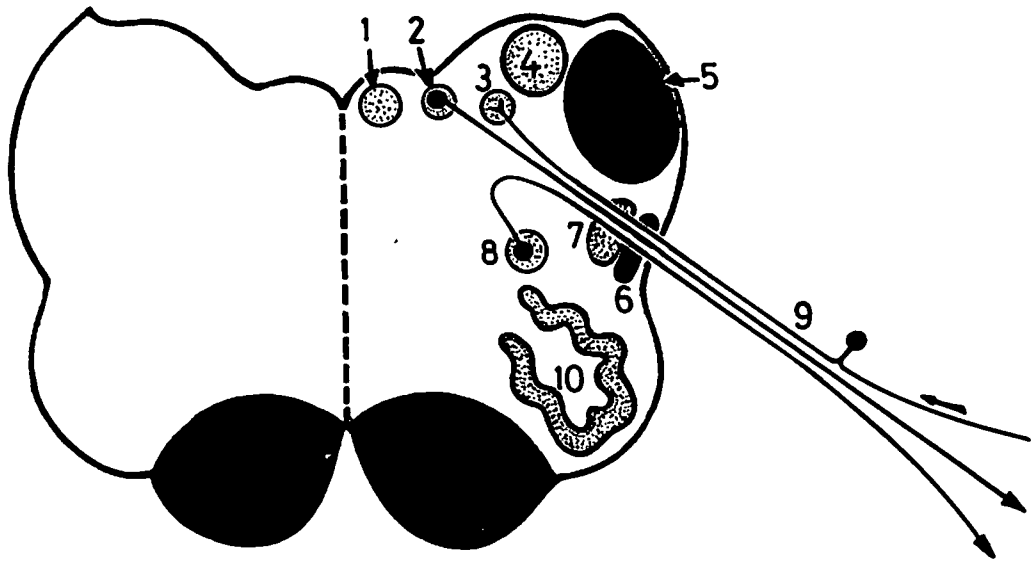


Fig.(85): NUCLEI OF VAGUS NERVE

These are the nucleus ambiguus, dorsal nucleus and nucleus solitarius.

1. hypoglossal nucleus.
2. dorsal nucleus of vagus (parasympathetic nucleus).
3. nucleus solitarius (receives taste fibres).
4. vestibular nuclei (medial and inferior).
5. inferior cerebellar peduncle.
6. spinal tract of trigeminal nerve.
7. spinal nucleus of trigeminal nerve (traversed by the fibres of vagus nerve).
8. nucleus ambiguus (motor to muscles of pharynx, larynx and palate).
9. emerging fibres of vagus nerve (between the olive and inferior cerebellar peduncle).
10. inferior olivary nucleus (forms the olive).

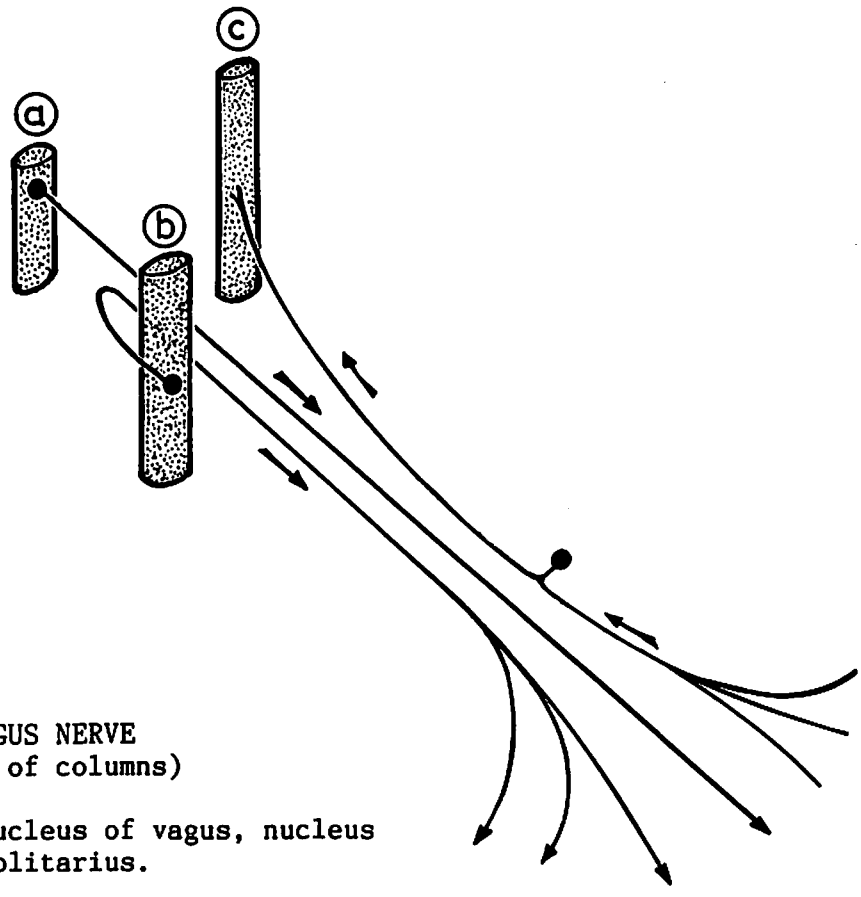


Fig.(86): NUCLEI OF VAGUS NERVE
(in the form of columns)

These are the dorsal nucleus of vagus, nucleus ambiguus and nucleus solitarius.

(a) Dorsal nucleus of vagus: it is a parasympathetic nucleus.

(b) Nucleus ambiguus: it is a motor nucleus which gives origin to the motor fibres of the glossopharyngeal, vagus and cranial root of accessory.

(c) Nucleus solitarius: it is a sensory nucleus which receives taste fibres through the facial, glossopharyngeal and vagus.

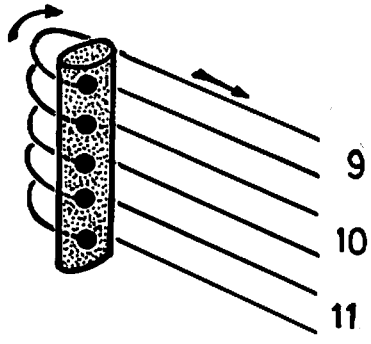
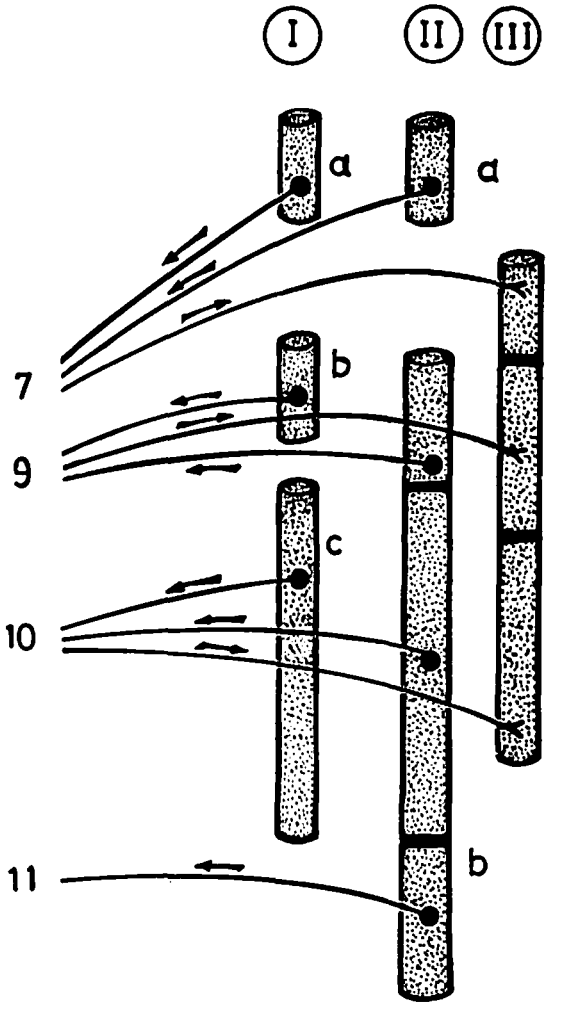


Fig.(87): NUCLEUS AMBIGUUS

The nucleus ambiguus gives motor fibres which pass through the glossopharyngeal, vagus and cranial root of accessory nerve. These fibres supply the muscles of the pharynx, larynx and palate (except the tensor palati).

Fig.(88): COLUMNS OF NUCLEI OF THE 7th, 9th, 10th and 11th CRANIAL NERVES



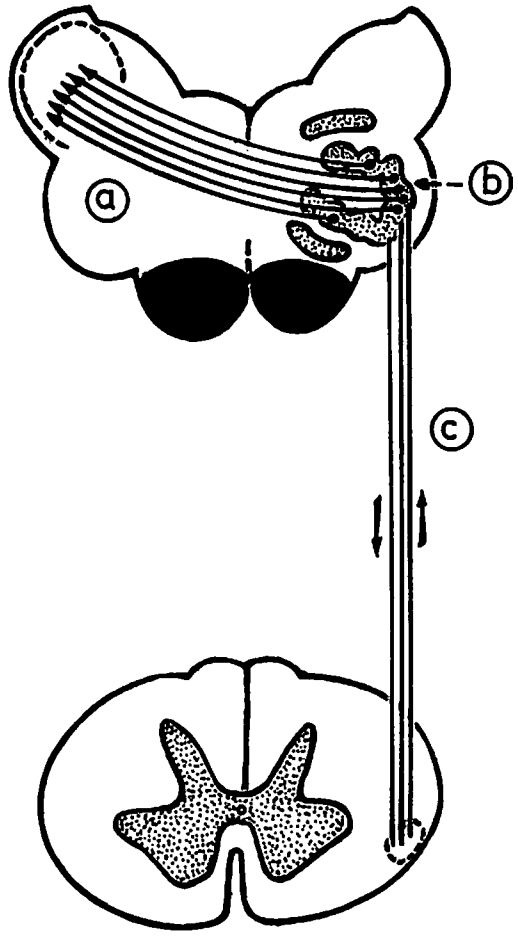
These nuclei lie in the medulla oblongata as well as in the pons.
They are 3 columns:

I. Column of parasympathetic nuclei (general visceral efferent): it includes:
   (a) superior salivatory nucleus for the facial.
   (b) inferior salivatory nucleus for the glossopharyngeal.
   (c) dorsal nucleus of vagus.

II. Column of motor nuclei (special visceral efferent): it includes:
   (a) motor nucleus of facial.
   (b) nucleus ambiguus for the glossopharyngeal, vagus and cranial root of accessory.

III. Column formed by the nucleus solitarius (special visceral afferent): It receives taste fibres from the facial, glossopharyngeal and vagus nerves.

Fig.(89): CONNECTIONS OF THE INFERIOR OLIVARY NUCLEUS WITH THE CEREBELLUM AND SPINAL CORD



The inferior olivary nucleus is a large mass present in the anterolateral region of the medulla oblongata. It is connected with the cerebellum through the olivocerebellar fibres, and with the spinal cord through the olivospinal and spino-olivary tracts.

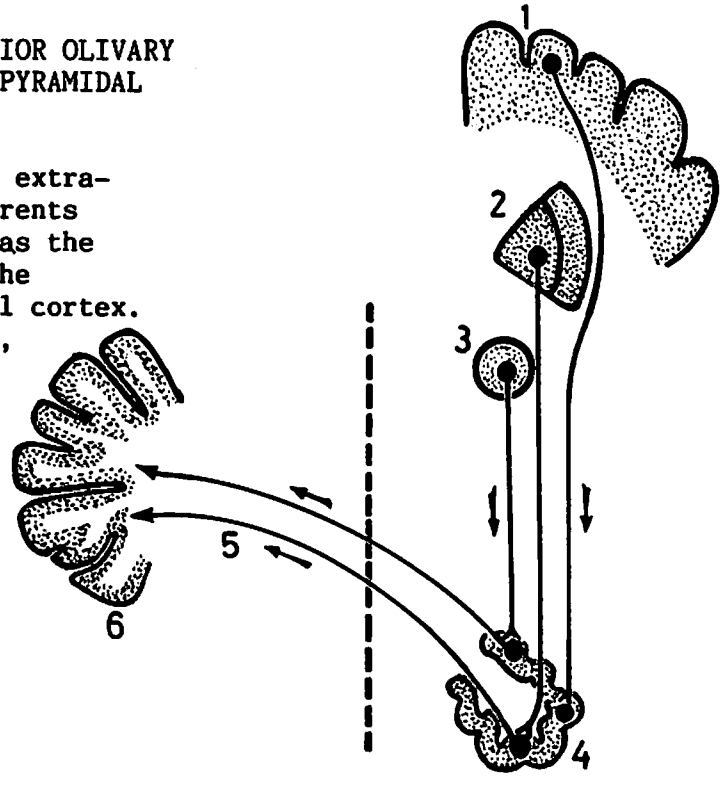
(a) olivocerebellar fibres: arise from the inferior olivary nucleus, cross the mid-line and enter the cerebellum through the inferior cerebellar peduncle.

(b) inferior olivary nucleus: a large nucleus with crenated walls, and has a hilum directed medially. It produces the elevation of the olive.

(c) olivospinal and spino-olivary tracts intermingling together.

* It is believed by some authors that the olivospinal tract does not arise from the inferior olivary nucleus itself but from the area around it.

Fig.(90): CONNECTIONS OF THE INFERIOR OLIVARY NUCLEUS WITH OTHER EXTRAPYRAMIDAL CENTRES

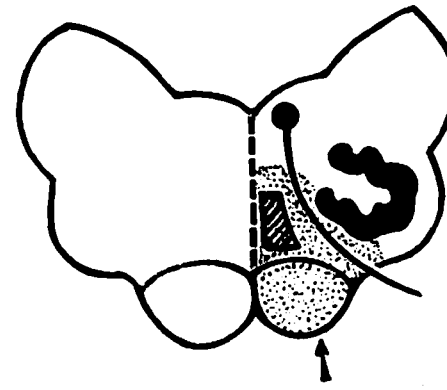


The inferior olivary nucleus is an extra-pyramidal centre. It receives afferents from other extrapyramidal centres as the red nucleus, corpus striatum and the extrapyramidal area of the cerebral cortex. Through the olivocerebellar fibres, these extrapyramidal centres get connection with the cerebellum.

1. extrapyramidal area of cerebral cortex (premotor area).
2. corpus striatum.
3. red nucleus.
4. inferior olivary nucleus.
5. olivocerebellar fibres.
6. cerebellum.

LESIONS OF MEDULLA OBLONGATA

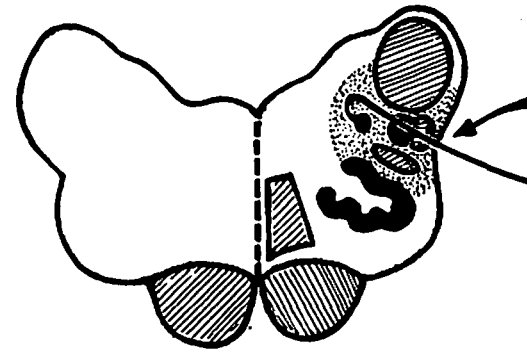
Fig.(91): MEDIAL MEDULLARY SYNDROME



It results from a lesion to the medial part of the medulla oblongata. The following structures are affected:

* pyramidal tract: leads to contralateral hemiplegia affecting the upper and lower limbs of the opposite side.
* medial lemniscus: leads to loss of proprioception and fine touch on the opposite side of the body (below the head).
* hypoglossal nerve: leads to paralysis of the tongue muscles on the same side as the lesion.

Fig.(92): LATERAL MEDULLARY SYNDROME



It results from a lesion to the lateral part of the medulla oblongata (usually due to occlusion of the posterior inferior cerebellar artery). The following structures are affected:

* lateral spinothalamic tract (spinal lemniscus): leads to loss of pain and temperature sensations on the opposite side of the body below the head.
* spinal tract of trigeminal nerve: leads to loss of pain and temperature sensations on the same side of the face.
* nucleus ambiguus: leads to paralysis of muscles of the pharynx, larynx and palate on the same side.
* inferior cerebellar peduncle: leads to cerebellar manifestations.

PONS

GROSS MORPHOLOGY

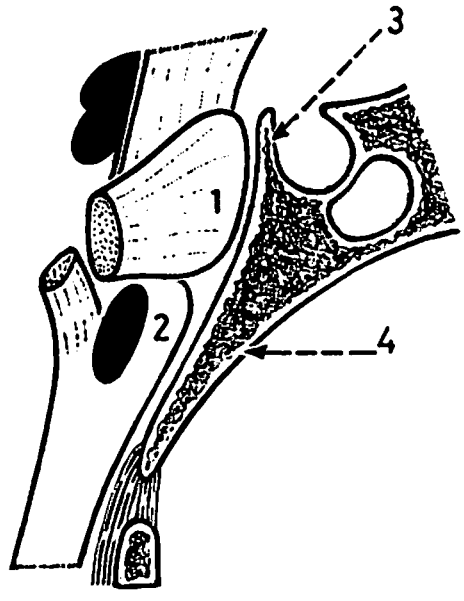


Fig.(93): POSITION OF THE PONS

The pons forms the middle part of the brain stem, and lies in contact with the dorsum sellae and basilar part of the occipital bone.

1. pons.
2. medulla oblongata.
3. dorsum sellae.
4. basilar part of occipital bone.

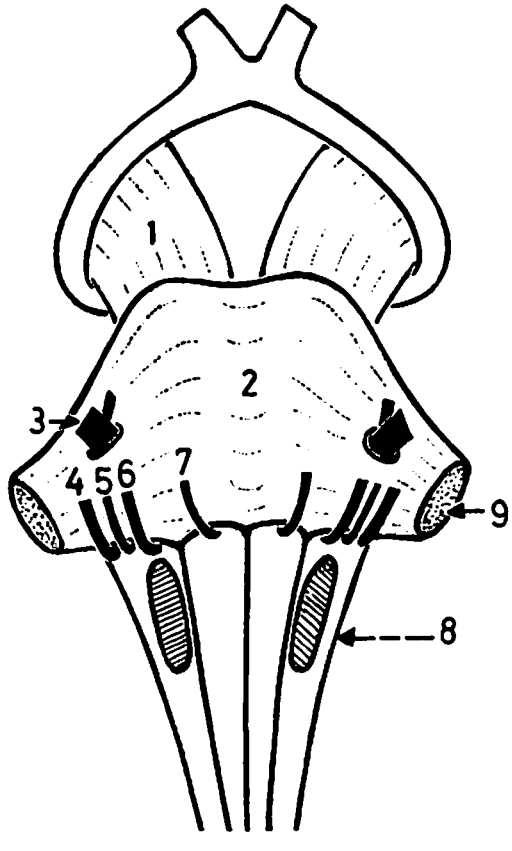


Fig.(94): ANTERIOR SURFACE OF THE PONS

It is marked by a shallow longitudinal median sulcus called basilar sulcus for the basilar artery. It is continuous laterally with the middle cerebellar peduncle, and is separated from the medulla by a transverse groove where the abducent, facial and vestibulo-cochlear nerves emerge.

1. midbrain.
2. basilar sulcus of the pons.
3. roots of trigeminal nerve attached at the junction between the pons and middle cerebellar peduncle.
4. vestibulocochlear nerve.
5. nervus intermedius (part of the facial nerve).
6. facial nerve.
7. abducent nerve.
8. medulla oblongata.
9. middle cerebellar peduncle.

Fig.(95): POSTERIOR SURFACE OF THE PONS

It forms the upper 1/2 of the floor of the 4th ventricle.

1. superior cerebellar peduncle.
2. middle cerebellar peduncle.
3. inferior cerebellar peduncle.
4. upper 1/2 of the floor of the 4th ventricle formed by the back of the pons.
5. facial colliculus (related to the back of the pons).
6. elevation formed by vestibular nuclei.
7. lower 1/2 of the floor of the 4th ventricle formed by the back of open medulla.
8. gracile tubercle.
9. cuneate tubercle.

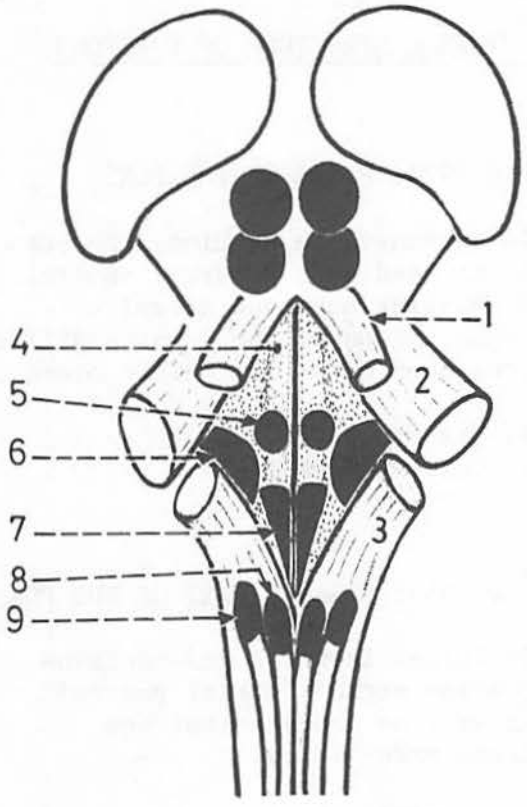
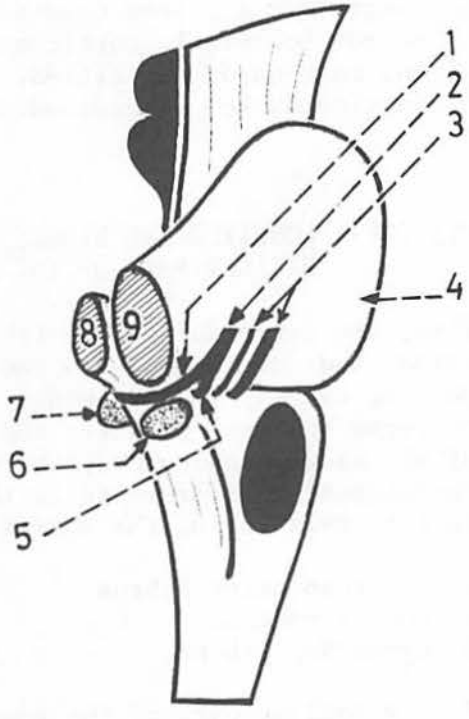


Fig.(96): SUPERFICIAL ATTACHMENTS OF THE FACIAL AND VESTIBULO-COCHLEAR NERVES

These nerves are attached to the side of the brainstem at the junction between the pons and medulla oblongata.

1. cochlear division of vestibulocochlear nerve (runs backwards crossing over the upper part of the inferior cerebellar peduncle very close to the cochlear nuclei).
2. vestibulocochlear (auditory) nerve.
3. facial nerve (medial to the vestibulo-cochlear nerve).
4. pons.
5. vestibular division of the vestibulo-cochlear nerve (enters the uppermost part of the medulla oblongata just medial to the inferior cerebellar peduncle).
6. ventral cochlear nucleus (lies on the anterolateral aspect of the inferior peduncle, close to the middle peduncle).
7. dorsal cochlear nucleus (lies on the posterior aspect of the inferior peduncle).
8. inferior cerebellar peduncle.
9. middle cerebellar peduncle.



INTERNAL STRUCTURE OF THE PONS

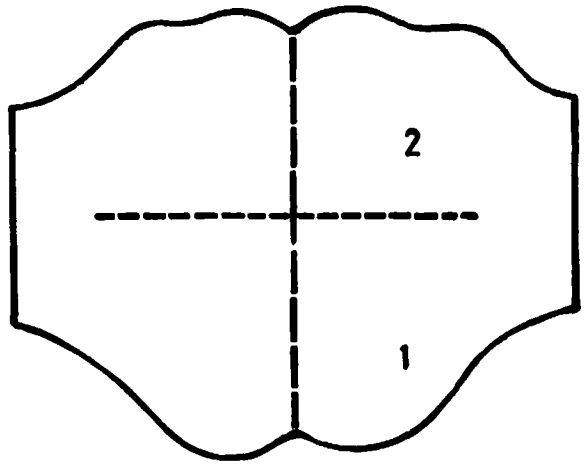


Fig.(97): PARTS OF THE PONS

In a transverse section, the pons is divided into 2 parts: ventral or basilar part and dorsal or tegmental part. The 2 parts differ from each other in their contents.

1. basilar part.
2. tegmental part.

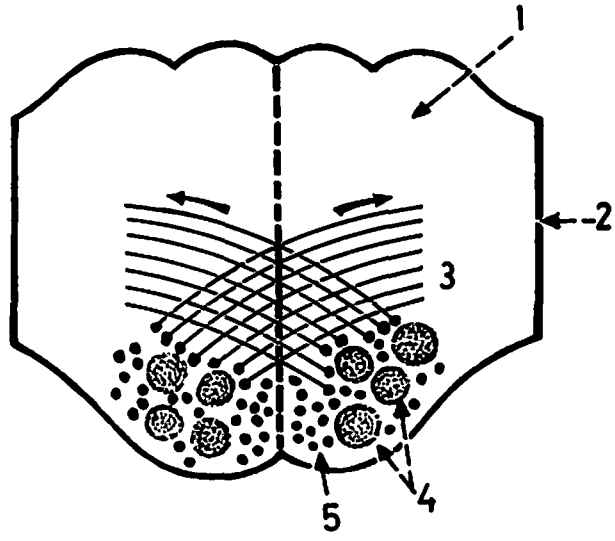


Fig.(98): BASILAR PART OF THE PONS

It bulges forwards and contains pontine nuclei (nuclei pontis) as well as longitudinal and transverse fibres.

1. tegmental part.
2. middle cerebellar peduncle.
3. pontocerebellar fibres (run transversely to enter the middle peduncle).
4. longitudinal fibres consisting of corticospinal, corticonuclear and corticopontine fibres.
5. pontine nuclei (nuclei pontis).

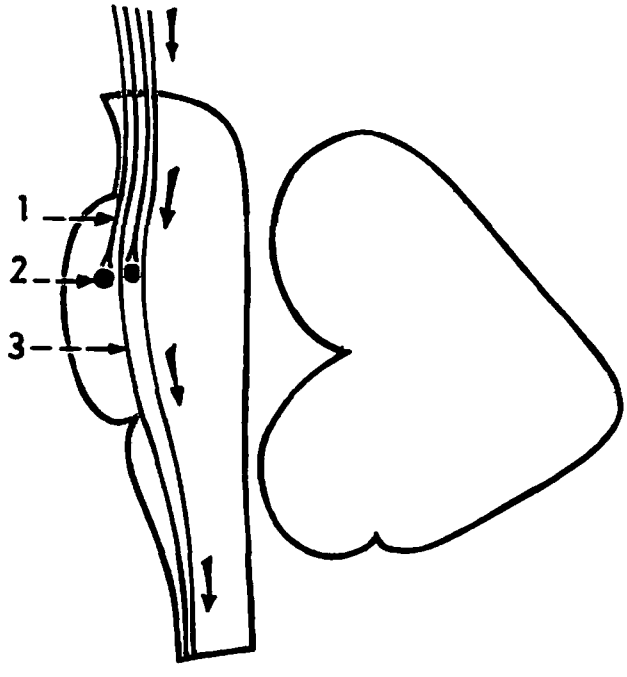


Fig.(99): LONGITUDINAL FIBRES IN THE BASILAR PART OF THE PONS

These are pyramidal fibres (corticospinal and corticonuclear) and corticopontine fibres. The pyramidal fibres traverse the pons to enter the pyramid of the medulla oblongata, while the corticopontine fibres end in the basilar part by relaying on the nuclei pontis.

1. corticopontine fibres.
2. nuclei pontis.
3. pyramidal fibres.

* The basilar part of the pons is continuous above with the crura of the midbrain and below with the pyramids of the medulla.

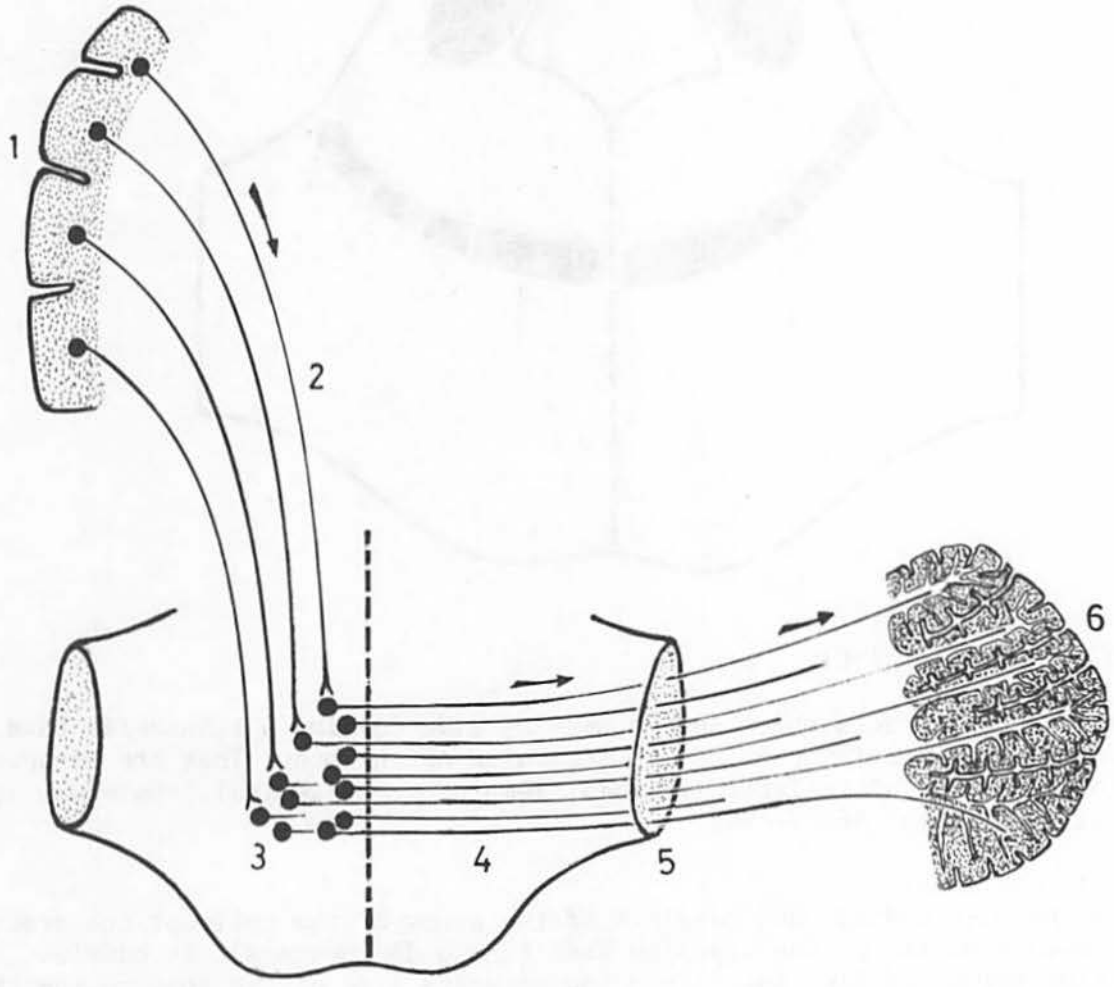


Fig.(100): CORTICO-PONTO-CEREBELLAR PATHWAY

This pathway consists of 2 neurons: corticopontine and pontocerebellar. The corticopontine fibres descend from the cerebral cortex to the basilar part of the pons where they relay on the pontine nuclei. The pontocerebellar fibres are the axons of the pontine nuclei which pass in the middle cerebellar peduncle to reach the cerebellar hemisphere of the opposite side.

1. cerebral cortex.
2. corticopontine fibres.
3. nuclei pontis in the basilar part of the pons.
4. pontocerebellar fibres crossing the midline to enter the middle cerebellar peduncle.
5. middle cerebellar peduncle.
6. cerebellum.

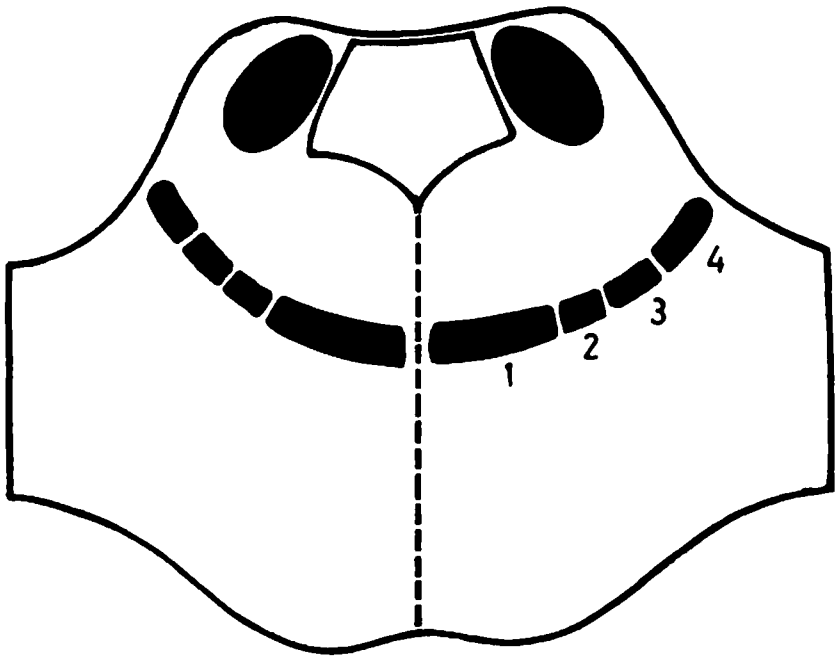


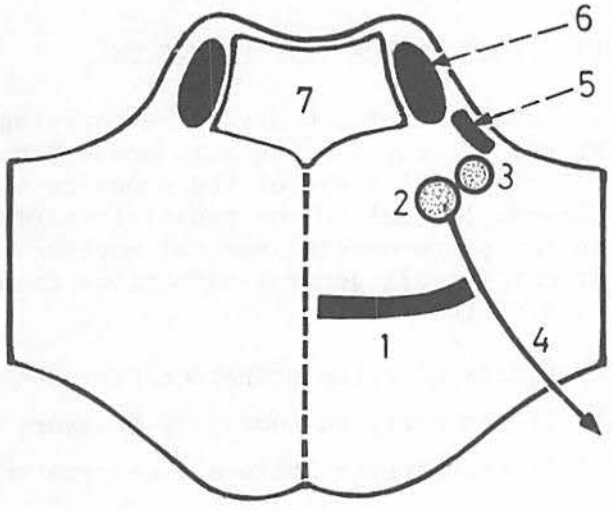
Fig.(101): THE 4 LEMNISCI

These are sensory tracts which ascend side by side forming a transverse band of fibres in the anterior part of the tegmentum of the pons. They are arranged as follows from medial to lateral: medial lemniscus, trigeminal lemniscus, spinal lemniscus and lateral lemniscus.

1. medial lemniscus:
   It is the most medial, and consists of the axons of the cells of the gracile and cuneate nuclei of the opposite side (2nd order neurons). It carries proprioception and fine touch from the opposite side of the body to the thalamus.
2. trigeminal lemniscus:
   It lies just lateral to the medial lemniscus, and consists of the axons of the cells of the sensory nuclei of the trigeminal nerve of the opposite side (2nd order neurons). It carries all types of general sensations from the opposite side of the face to the thalamus.
3. spinal lemniscus:
   It lies just lateral to the trigeminal lemniscus, and consists of the lateral and anterior spinothalamic tracts. It carries pain, temperature and crude touch from the opposite side of the body below the head to the thalamus. Its fibres are also 2nd order neurons.
4. lateral lemniscus:
   It is the most lateral lemniscus, and consists of cochlear fibres. It carries the sense of hearing from both ears to the medial geniculate body (not the thalamus).

* In other views, the lateral spinothalamic tract forms the spinal lemniscus, while the anterior spinothalamic tract joins the medial lemniscus in the brainstem.

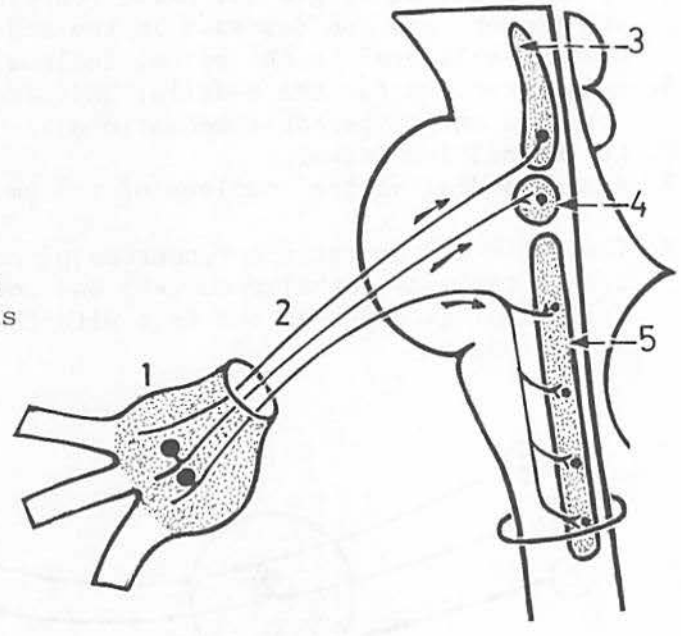
Fig.(102): MOTOR NUCLEUS OF TRIGEMINAL NERVE



It lies in the lateral part of the tegmentum of the pons with the main sensory nucleus of trigeminal nerve just lateral to it. Its fibres are distributed through the mandibular division of trigeminal nerve.

1. the 4 lemnisci (at the junction between the tegmentum and the basilar part of the pons).
2. motor nucleus of trigeminal nerve.
3. main sensory nucleus of trigeminal nerve.
4. motor root of trigeminal nerve (emerges at the junction between the pons and middle cerebellar peduncle).
5. anterior spinocerebellar tract (on its way to enter the superior cerebellar peduncle).
6. superior cerebellar peduncle.
7. 4th ventricle.

Fig.(103): SENSORY NUCLEI OF TRIGEMINAL NERVE



These are 3 nuclei: spinal nucleus (in the medulla), main sensory nucleus (in the pons) and mesencephalic nucleus (in the midbrain).

1. trigeminal ganglion.
2. sensory root of trigeminal nerve.
3. mesencephalic nucleus (for proprioception).
4. main (principal) sensory nucleus (for touch and pressure).
5. spinal nucleus (for pain and temperature).

* The sensory nuclei of trigeminal nerve extend throughout the whole extent of the brainstem, and receive all general sensations from the same side of the face.

* The spinal nucleus also receives general sensations from both the glosso-pharyngeal and vagus nerves.

Fig.(104): TRIGEMINAL LEMNISCUS

It is a band of sensory fibres arising from the spinal nucleus and the main sensory nucleus of trigeminal nerve of the opposite side. It ascends lateral to the medial lemniscus to end in the posteromedial ventral nucleus of thalamus. It carries all general sensations from the opposite side of the face.

(a) fibres carrying proprioceptive sensations.

(b) fibres carrying touch and pressure sensations.

(c) fibres carrying pain and temperature sensations.

1. trigeminal ganglion (1st order neurons for touch, pain and temperature sensations).
2. mesencephalic nucleus (in the midbrain; 1st order neurons for proprioceptive sensations).
3. main sensory nucleus (in the pons; 2nd order neurons for touch and pressure; it also receives the proprioceptive fibres from the mesencephalic nucleus).
4. spinal tract of trigeminal nerve (carries pain and temperature and descends in the medulla oblongata lateral to the spinal nucleus).
5. spinal nucleus (in the medulla; 2nd order neurons for pain and temperature sensations).
6. trigeminal lemniscus.
7. posteromedial ventral nucleus of thalamus.

* The cells of the 1st order neurons of proprioception lie in the mesencephalic nucleus and not in the trigeminal ganglion as the case with the other sensations.

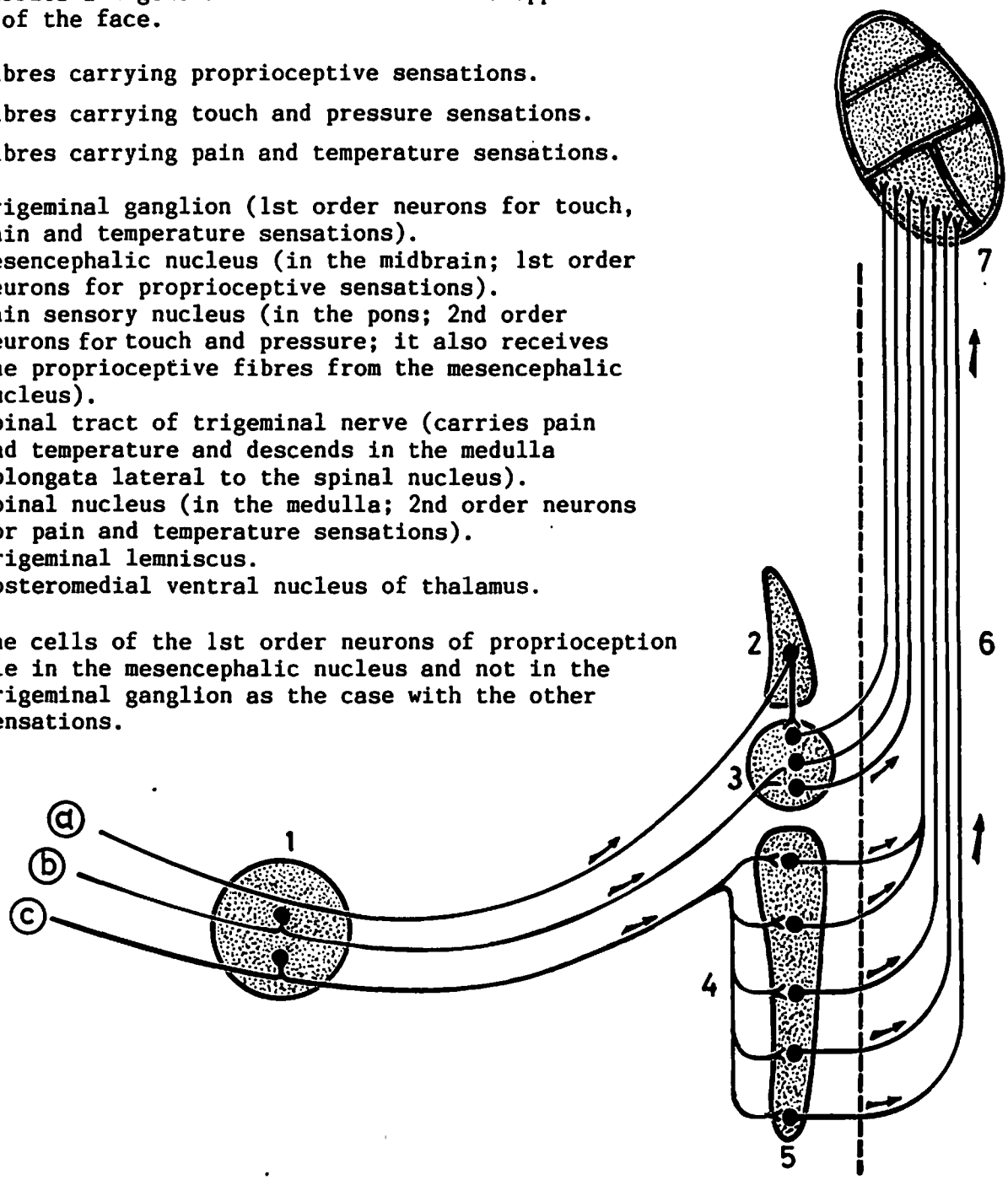
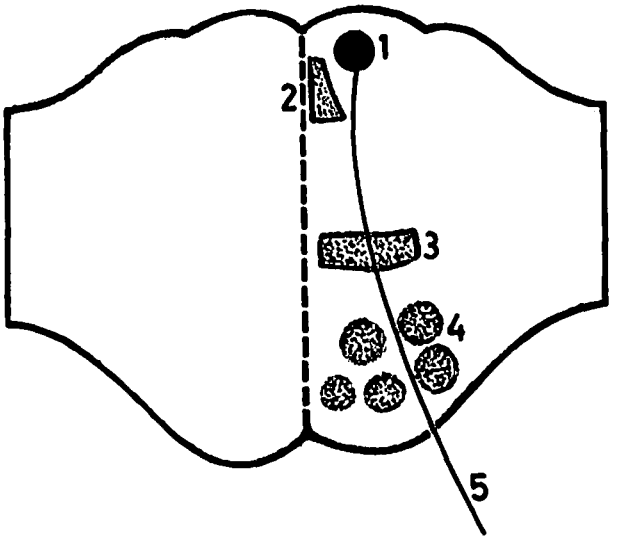


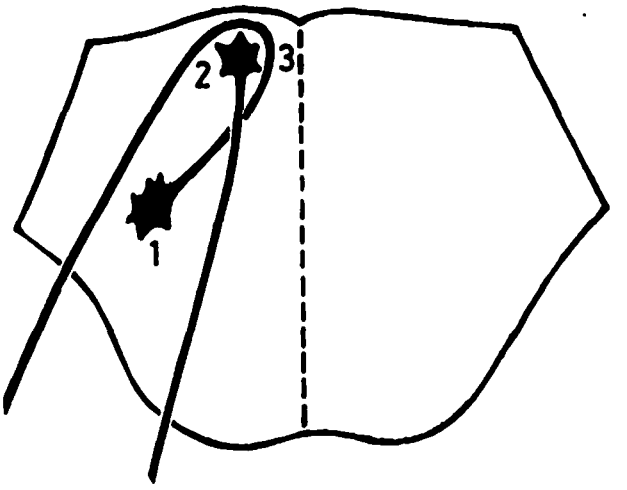
Fig.(105): NUCLEUS OF ABDUCENT NERVE



It lies in the most posterior part of the pons (in the floor of the 4th ventricle), close to the midline. The fibres of the abducent nerve run forwards and downwards traversing the medial lemniscus in the tegmentum, and the pyramidal fibres in the basilar part of the pons.

1. nucleus of abducent nerve.
2. medial longitudinal bundle.
3. medial lemniscus.
4. pyramidal fibres in the basilar part of the pons.
5. abducent nerve (emerges at the lower border of the pons, just above the pyramid).

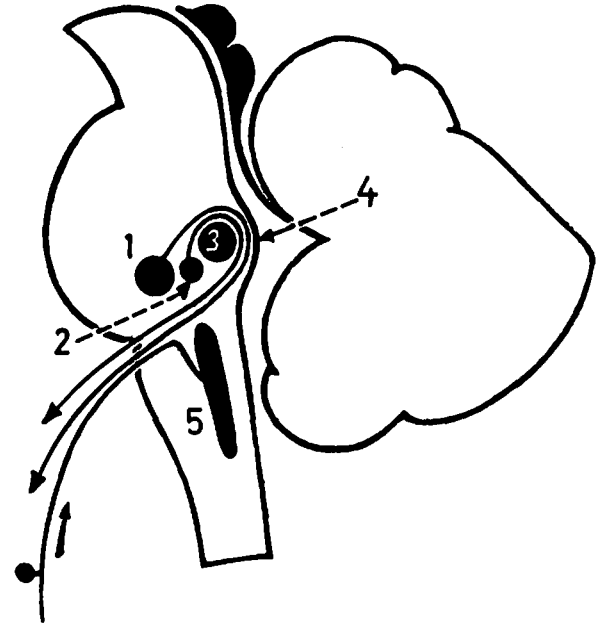
Fig.(106): FACIAL COLLICULUS



It is an elevation in the floor of the 4th ventricle formed by the nucleus of abducent nerve together with the fibres of the facial nerve winding around it.

1. nucleus of facial nerve.
2. nucleus of abducent nerve.
3. fibres of facial nerve winding around the nucleus of abducent nerve to form together the facial colliculus.

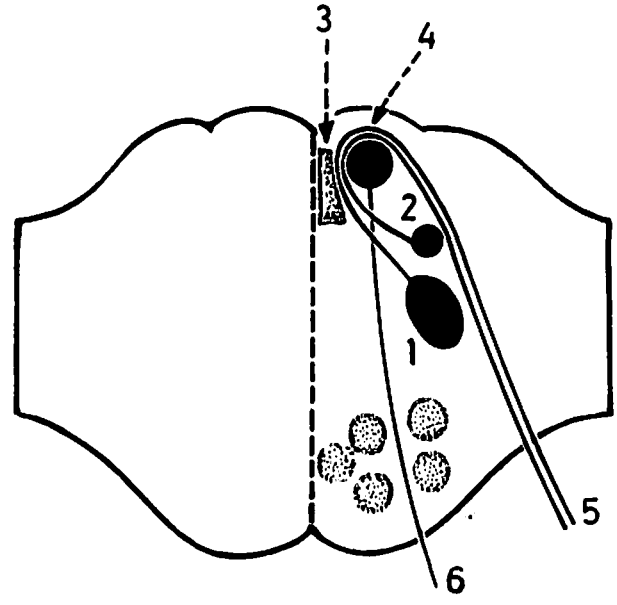
Fig.(107): NUCLEI OF FACIAL NERVE



These are 3 nuclei: motor nucleus, superior salivatory nucleus (parasympathetic) and nucleus solitarius (for taste).

1. motor nucleus of facial nerve.
2. superior salivatory nucleus (parasympathetic to the submandibular, sublingual and lacrimal glands).
3. nucleus of abducent nerve.
4. facial colliculus in the floor of the 4th ventricle.
5. nucleus solitarius (lies in the medulla and its upper part receives taste fibres from the facial nerve).

Fig.(108): COURSE OF FACIAL NERVE IN THE PONS



The motor nucleus of facial nerve lies in the lowermost part of the tegmentum of the pons, just below the motor nucleus of trigeminal nerve. Its fibres pass posteromedially to wind round the nucleus of abducent nerve forming the genu of the facial nerve. The fibres then run forwards and laterally to emerge on the side of the brainstem at the lower border of the pons. In their course in the pons, these motor fibres are joined by the parasympathetic fibres from the superior salivatory nucleus.

1. motor nucleus of facial nerve.
2. superior salivatory nucleus.
3. medial longitudinal bundle.
4. genu of the facial nerve surrounding the abducent nucleus.
5. emerging fibres of facial nerve.
6. emerging fibres of abducent nerve.

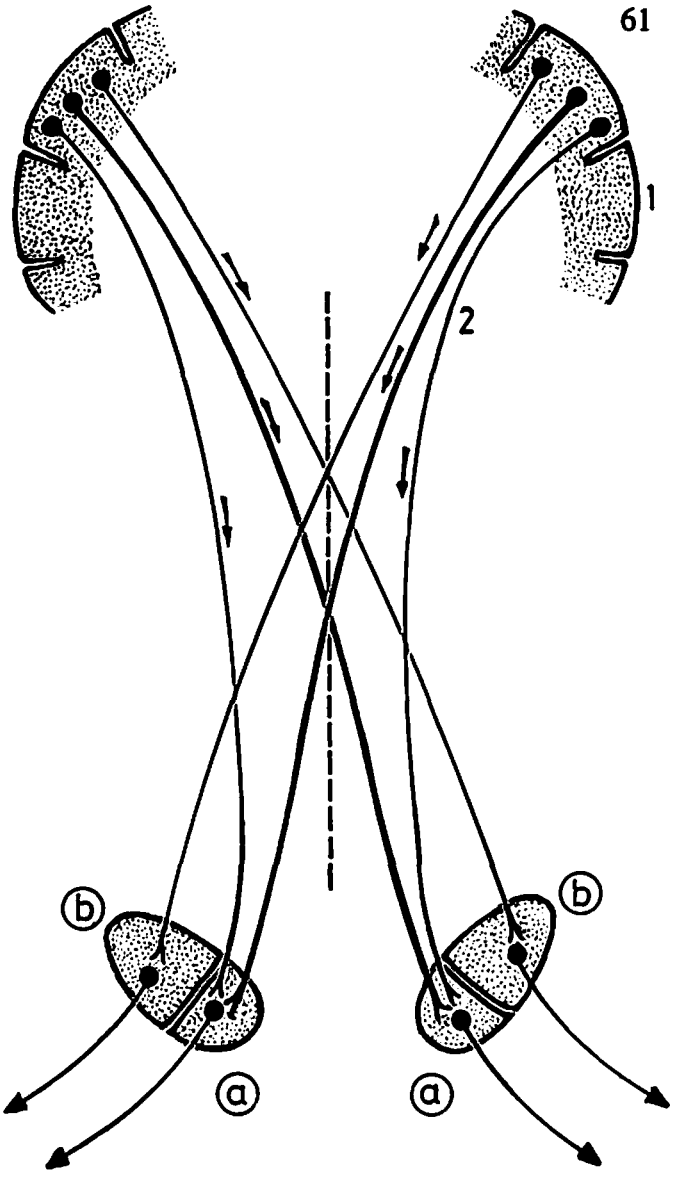
Fig.(109): PARTS OF THE MOTOR NUCLEUS OF FACIAL NERVE

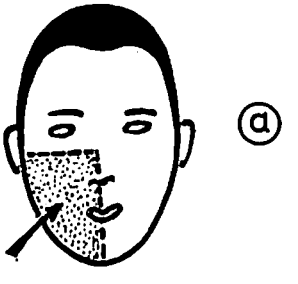
The motor nucleus of facial nerve consists of 2 parts : dorsal and ventral. The dorsal part supplies the upper part of the face and receives corticonuclear fibres from both cerebral hemispheres. The ventral part supplies the lower part of the face (buccinator) and receives corticonuclear fibres from the contralateral cerebral hemisphere.

(a) dorsal part of the nucleus.

(b) ventral part of the nucleus.

1. motor area of the cerebral cortex.
2. corticonuclear fibres to the facial nuclei.





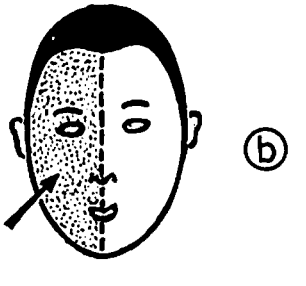
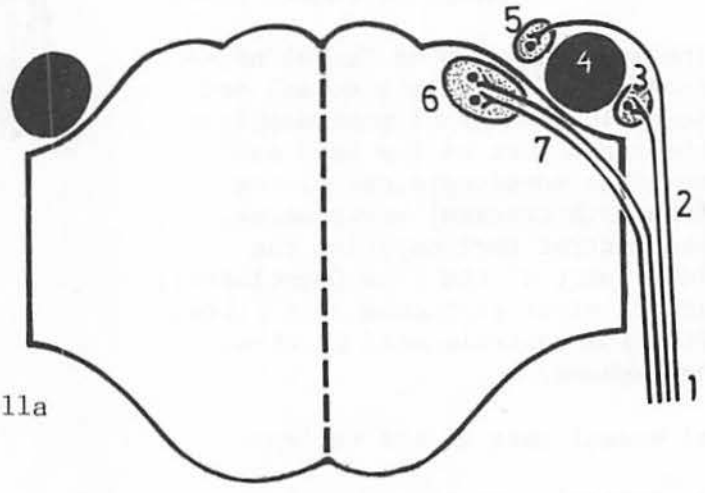


Fig.(110): PARALYSIS OF FACIAL NERVE

(a) Upper motor neuron lesion of left facial nerve: in this lesion, the corticonuclear fibres on the left side are damaged. As a result, the ventral part of the facial nucleus on the right side is completely affected, while the dorsal part is partially affected. Accordingly, the lower part of the face on the right side is paralysed.

(b) Lower motor neuron lesion of right facial nerve: in this lesion, the nucleus or the emerging fibres of the facial nerve on the right side are damaged resulting in paralysis of the whole right 1/2 of the face.

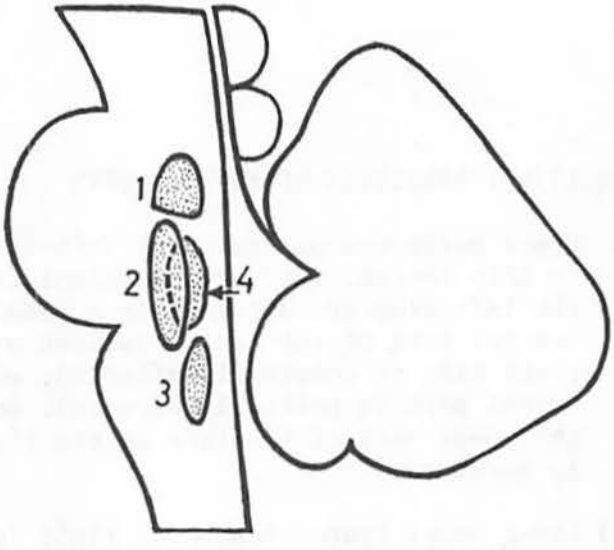
Fig.(111): COCHLEAR AND VESTIBULAR DIVISIONS OF THE VESTIBULOCOCHLEAR NERVE



The vestibulocochlear nerve divides into 2 divisions: cochlear and vestibular. The cochlear division passes backwards on the lateral surface of the inferior cerebellar peduncle to end in the ventral and dorsal cochlear nuclei. The vestibular division pierces the medulla oblongata medial to the inferior cerebellar peduncle to end in the vestibular nuclei.

1. vestibulocochlear nerve.
2. cochlear division.
3. ventral cochlear nucleus (ventral to the inferior cerebellar peduncle).
4. upper part of the inferior cerebellar peduncle.
5. dorsal cochlear nucleus (dorsal to the upper part of the inferior cerebellar peduncle).
6. group of vestibular nuclei (lie partly in the medulla and partly in the pons).
7. vestibular division.

Fig.(112): VESTIBULAR NUCLEI



These are 4 nuclei: medial, lateral, superior and inferior. The superior, lateral and upper part of the medial nucleus lie in the pons, while the inferior and lower part of the medial nucleus lie in the medulla oblongata.

1. superior vestibular nucleus (lies in the pons above the others).
2. medial vestibular nucleus (the largest and lies partly in the pons and partly in the medulla).
3. inferior vestibular nucleus (lies in the medulla below the lateral nucleus).
4. lateral vestibular nucleus (lies in the pons lateral to the medial nucleus).

Fig.(113): AFFERENT FIBRES TO THE VESTIBULAR NUCLEI

The vestibular nuclei receive afferent fibres from the vestibulocochlear nerve as well as from the cerebellum.

1. vestibular division of vestibulocochlear nerve.
2. vestibular nuclei.
3. afferent fibres from the cerebellum.

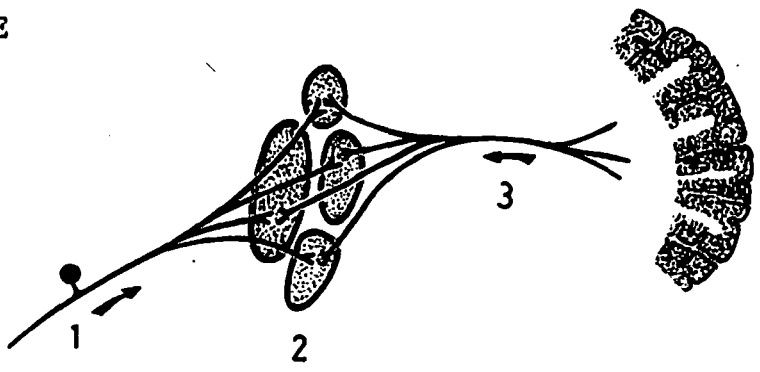


Fig.(114): EFFERENT FIBRES FROM THE VESTIBULAR NUCLEI

The vestibular nuclei send efferent fibres to the medial longitudinal bundle, spinal cord and cerebellum.

1. vestibular group of nuclei.
2. efferent fibres to the medial longitudinal bundle.
3. vestibulospinal fibres (from the lateral nucleus to the spinal cord).
4. vestibulocerebellar fibres (to the cerebellum).

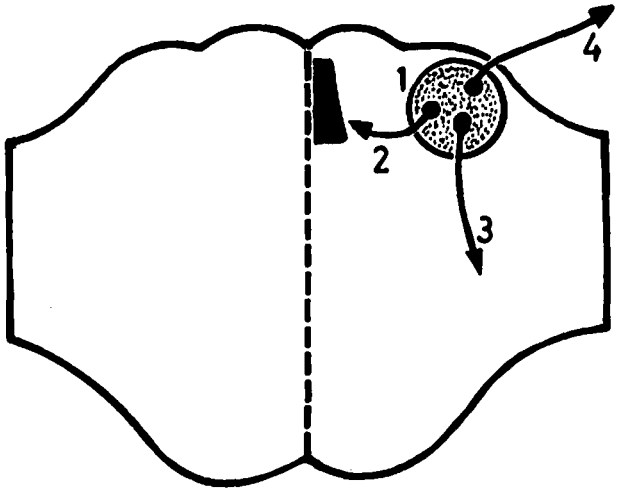


Fig.(115): EFFERENT FIBRES OF THE VENTRAL COCHLEAR NUCLEUS

These fibres are distributed to the nuclei of trapezoid body on both sides and to the nucleus of lateral lemniscus on the same side.

1. lateral lemniscus.
2. nucleus of lateral lemniscus.
3. dorsal cochlear nucleus (has the same efferents as the ventral cochlear nucleus).
4. inferior cerebellar peduncle.
5. ventral cochlear nucleus.
6. nuclei of trapezoid body (trapezoid nucleus and superior olivary nucleus).
7. fibres crossing the midline to end in the nuclei of trapezoid body on the opposite side.

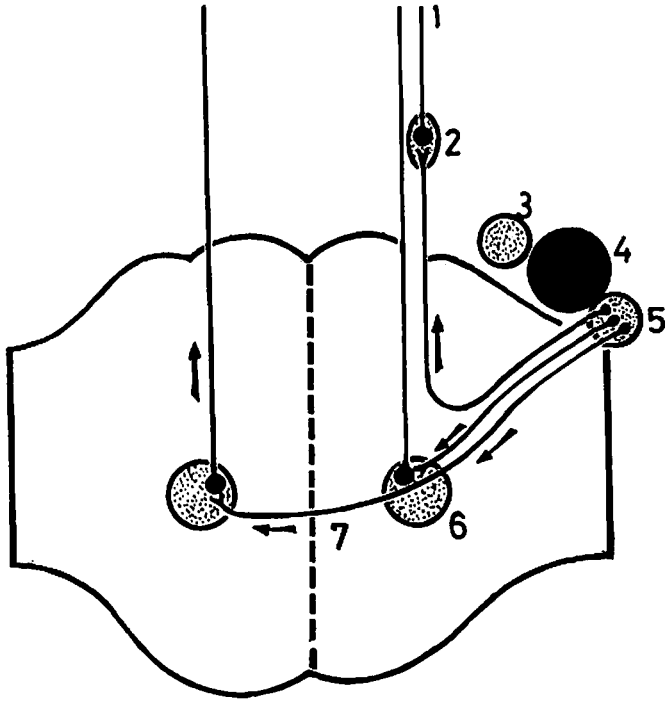


Fig.(116): FORMATION OF THE TRAPEZOID BODY

The trapezoid body is formed of cochlear fibres which arise from the ventral and dorsal cochlear nuclei and decussate in the midline of the lower part of the pons. There are a number of nuclei associated with this trapezoid body; these are mainly the trapezoid nuclei and superior olivary nucleus.

1. dorsal cochlear nucleus (shares in the formation of the trapezoid body).
2. ventral cochlear nucleus (most of its efferents cross to the opposite side in the trapezoid body).
3. nuclei of the trapezoid body.
4. decussating fibres of the trapezoid body.

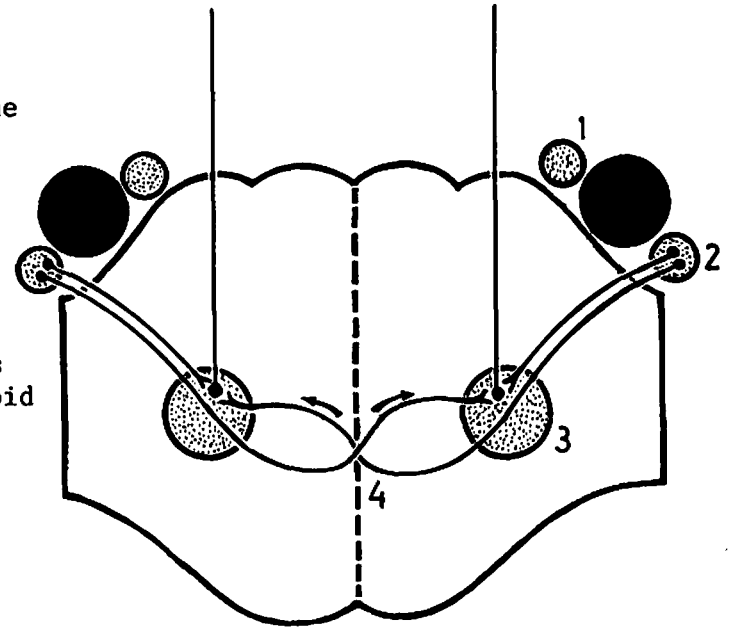


Fig.(117): POSITION OF THE TRAPEZOID BODY

This large decussation of cochlear fibres lies just behind the basilar part of the pons just above the medulla. It is traversed by the fibres of the abducent nerve, and may intersect the ascending fibres of the medial lemniscus.

1. facial colliculus.
2. vestibular nuclei (in the floor of the 4th ventricle).
3. facial nerve.
4. trapezoid body.
5. abducent nerve.

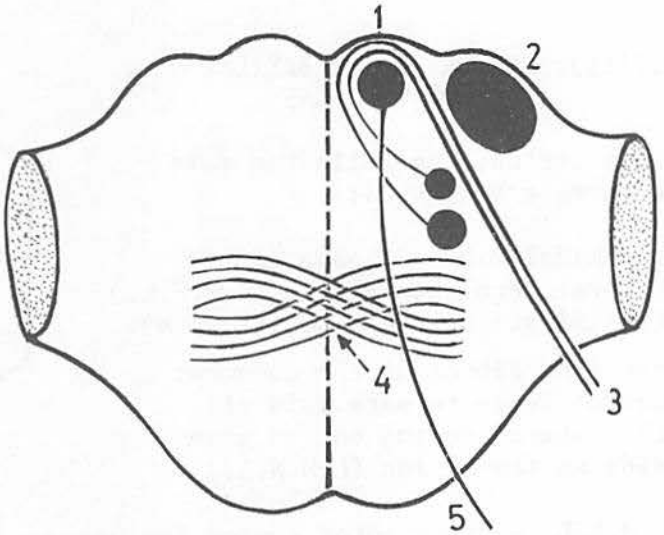
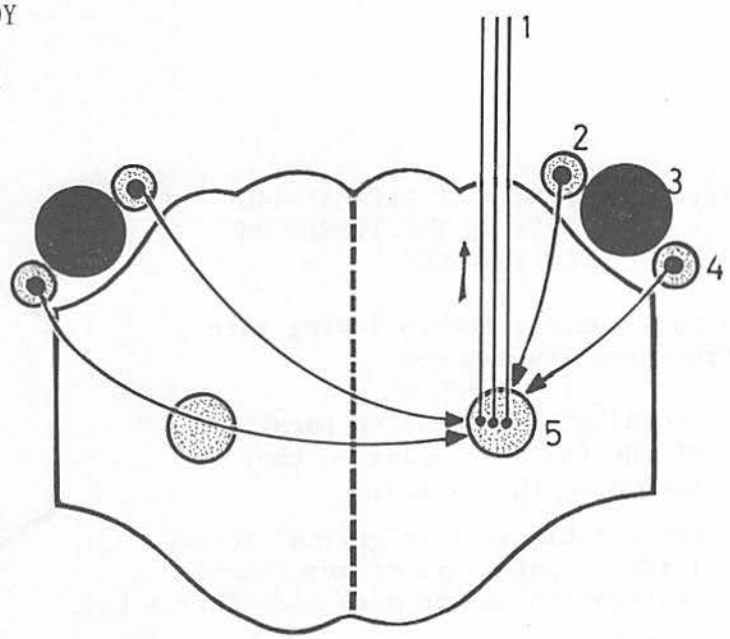


Fig.(118): NUCLEI OF TRAPEZOID BODY

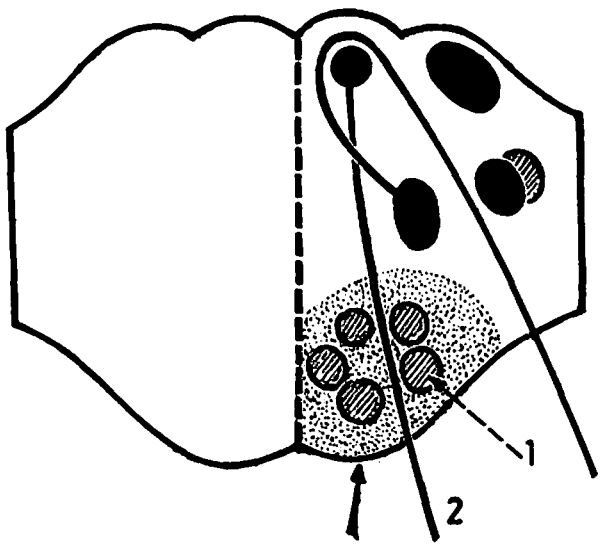
These nuclei include the trapezoid nuclei as well as the superior olivary nucleus. They receive afferent fibres from both sides (mainly from the opposite side), and send efferents to form the lateral lemniscus.

1. lateral lemniscus.
2. dorsal cochlear nucleus.
3. inferior cerebellar peduncle.
4. ventral cochlear nucleus.
5. nuclei of trapezoid body.



LESIONS OF THE PONS

Fig.(119): LESION TO THE BASILAR PART OF THE PONS



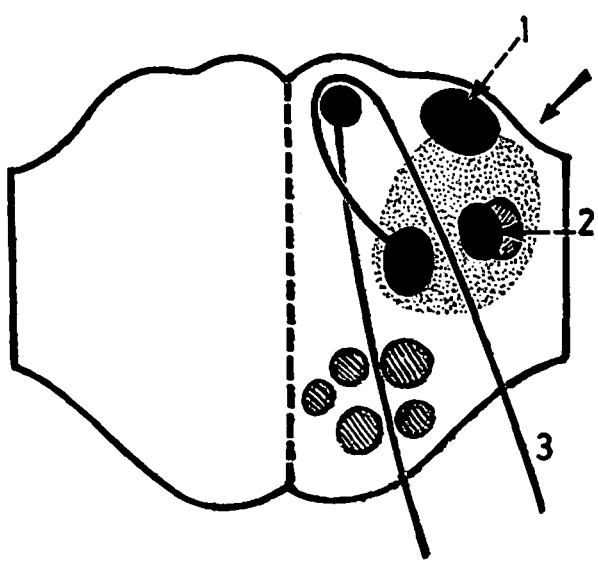
In this lesion, the following main structures are damaged:

* pyramidal fibres: leads to contralateral hemiplegia (U.M.N.L.) (hemiplegia on the opposite side).
* emerging fibres of the abducent nerve: leads to paralysis of the lateral rectus on the same side as the lesion (L.M.N.L.)

U.M.N.L. = upper motor neuron lesion.
L.M.N.L. = lower motor neuron lesion.

1. pyramidal fibres.
2. abducent nerve.

Fig.(120): LESION TO THE LATERAL PART OF THE TEGMENTUM OF THE PONS



In this lesion, the following main structures are damaged:

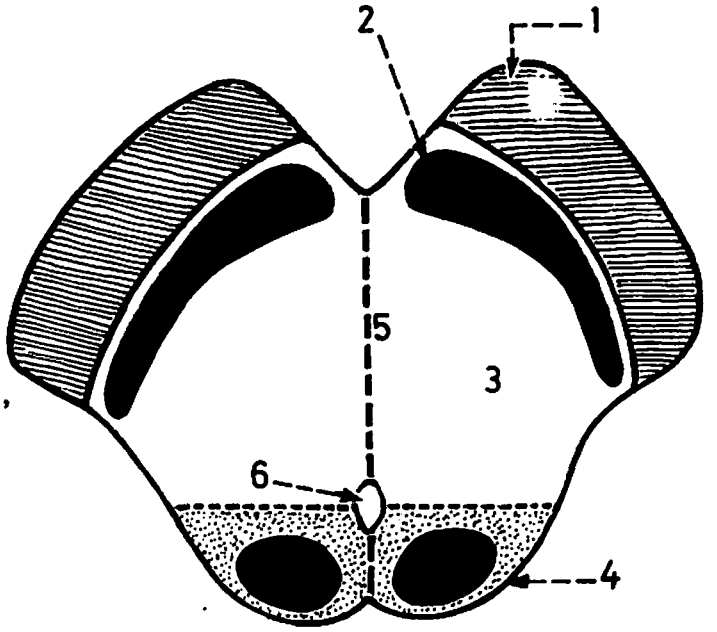
* facial nerve: leads to paralysis of the facial muscles on the same side (L.M.N.L.).
* motor nucleus of trigeminal nerve: leads to paralysis of muscles of mastication on the same side (L.M.N.L.).
* vestibular nuclei: leads to disturbance of equilibrium.

1. vestibular nuclei.
2. motor nucleus of trigeminal nerve.
3. facial nerve.

MIDBRAIN

GROSS MORPHOLOGY

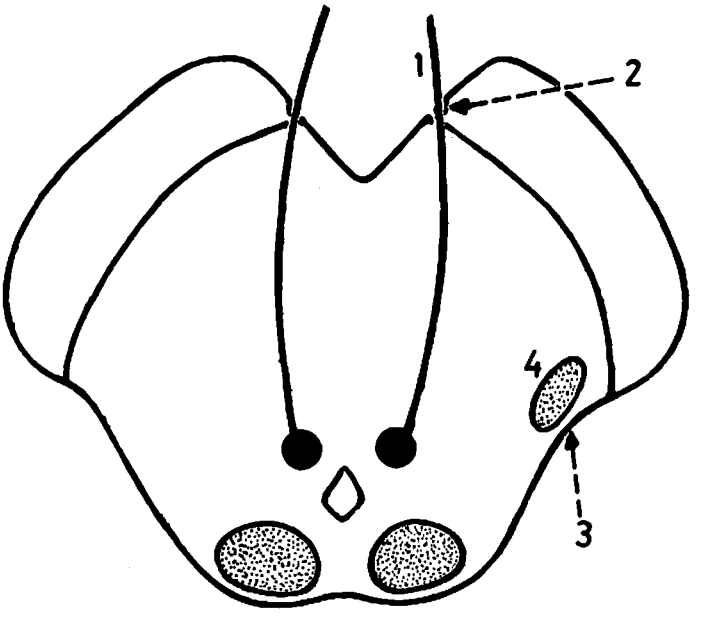
Fig.(121): PARTS OF MIDBRAIN
(cross section)



The part of the midbrain in front of the plane of the cerebral aqueduct is formed by the 2 cerebral peduncles (right and left), while the part behind the aqueduct is called the tectum. Each cerebral peduncle is subdivided into 3 parts: crus cerebri, substantia nigra and tegmentum (from before backwards).

1. crus cerebri.
2. substantia nigra.
3. tegmentum.
4. tectum.
5. midline between the 2 cerebral peduncles.
6. cerebral aqueduct (connects the the 4th ventricle below with the 3rd ventricle above).

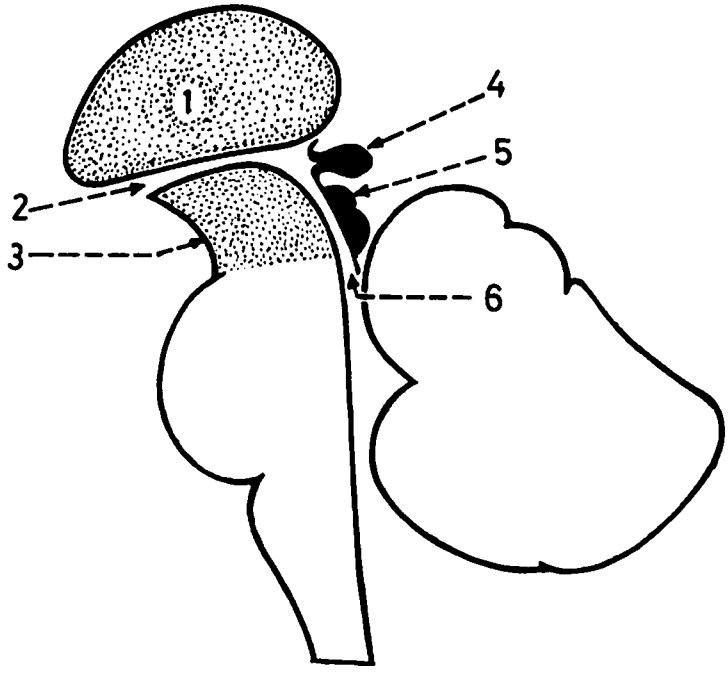
Fig.(122): MEDIAL AND LATERAL
SULCI OF MIDBRAIN



The surface of the midbrain shows 2 sulci: medial and lateral. The medial sulcus lies on the medial surface of the crus cerebri at which site the oculomotor nerve emerges. The lateral sulcus lies on the side of the cerebral peduncle just behind the crus cerebri, and it overlies the lateral lemniscus.

1. oculomotor nerve.
2. medial sulcus of midbrain.
3. lateral sulcus of midbrain.
4. lateral lemniscus.

Fig.(123): POSITION OF MIDBRAIN



The midbrain (mesencephalon) is the uppermost and shortest part of brainstem (1 inch long). It is related above to the 2 thalami (1 on each side), and is separated from each thalamus by the subthalamus. It is traversed longitudinally near its posterior aspect by the cerebral aqueduct.

1. thalamus.
2. site of the subthalamus (between the thalamus and tegmentum of the midbrain).
3. midbrain.
4. pineal body.
5. tectum of midbrain.
6. cerebral aqueduct.

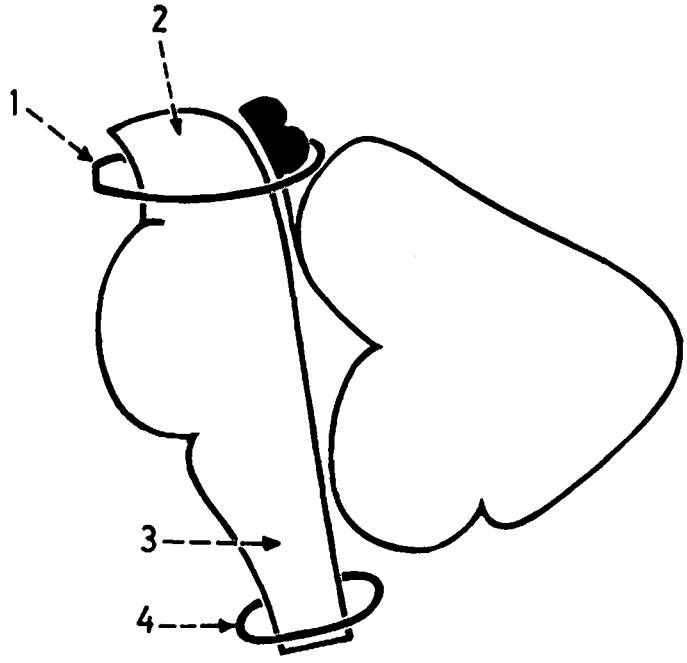


Fig.(124): MIDBRAIN IN THE TENTORIAL NOTCH

The midbrain traverses the tentorial notch which is the gap in the tentorium cerebelli.

1. tentorial notch.
2. midbrain.
3. medulla oblongata.
4. foramen magnum.

* The midbrain and medulla oblongata are exposed to compression in case of herniation of the temporal lobe through the tentorial notch, and herniation of the tonsil of the cerebellum through the foramen magnum.

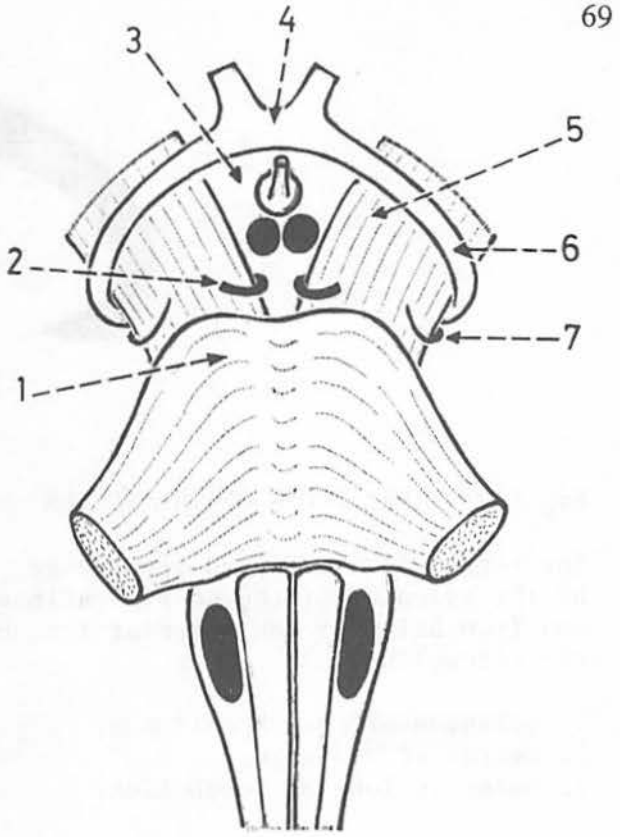


Fig.(125): ANTERIOR ASPECT OF MIDBRAIN

It is formed of the 2 crura (one on each side) and the interpeduncular fossa in between. This aspect also shows the 2 oculomotor nerves as they emerge in the interpeduncular fossa.

1. pons.
2. oculomotor nerve.
3. interpeduncular fossa.
4. optic chiasma.
5. crus cerebri.
6. optic tract.
7. trochlear nerve.

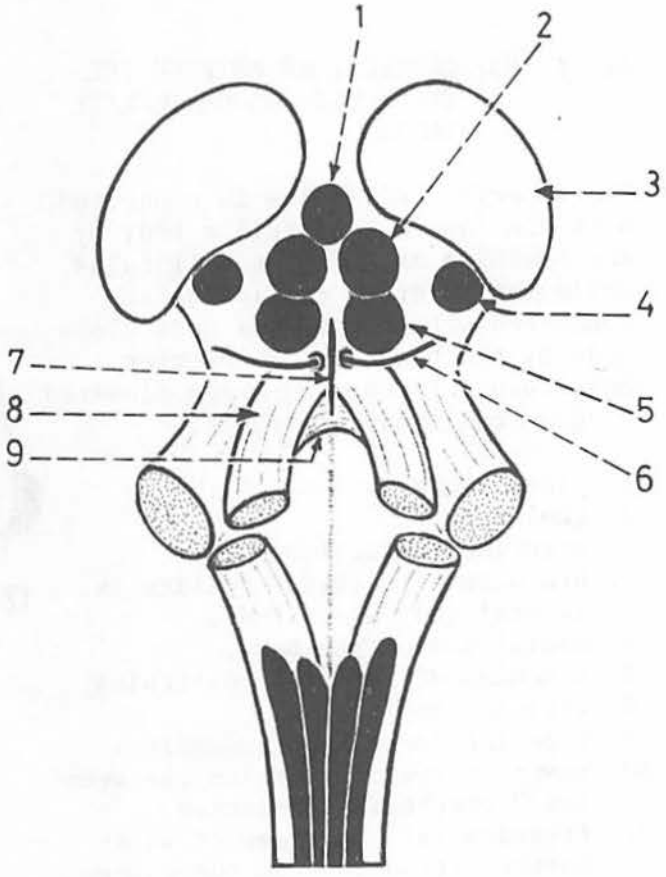


Fig.(126): POSTERIOR ASPECT OF MIDBRAIN

This aspect is formed by the tectum which consists of 4 rounded small swellings called colliculi (2 superior and 2 inferior). The superior colliculi are related above to the pineal body, while the inferior colliculi are related below to the 2 superior cerebellar peduncles. The trochlear nerves emerge from the posterior aspect, one on each side of the frenulum veli.

1. pineal body.
2. superior colliculus.
3. thalamus.
4. medial geniculate body.
5. inferior colliculus.
6. trochlear nerve.
7. frenulum veli.
8. superior cerebellar peduncle.
9. superior medullary velum.

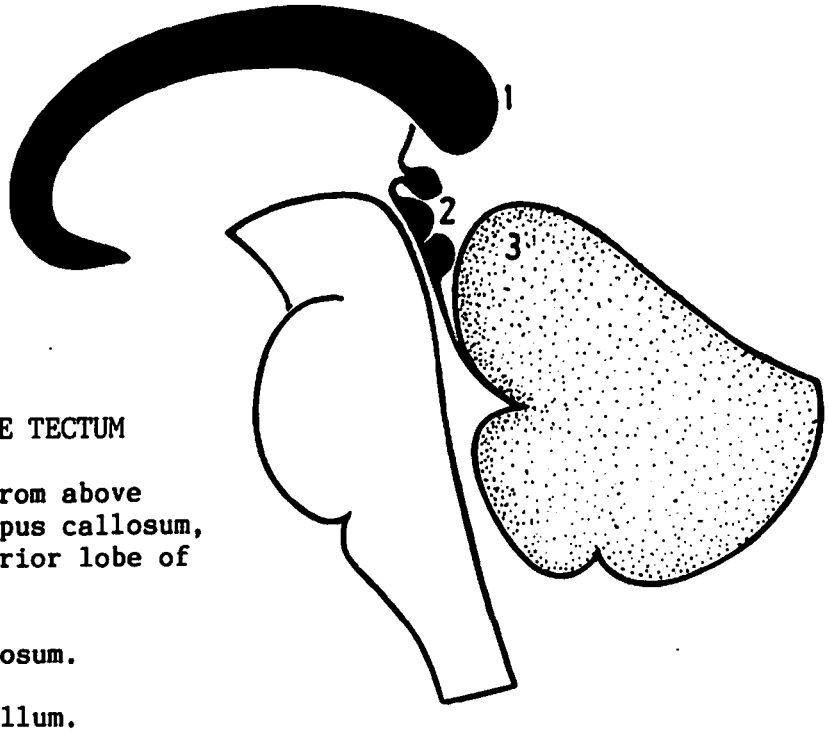


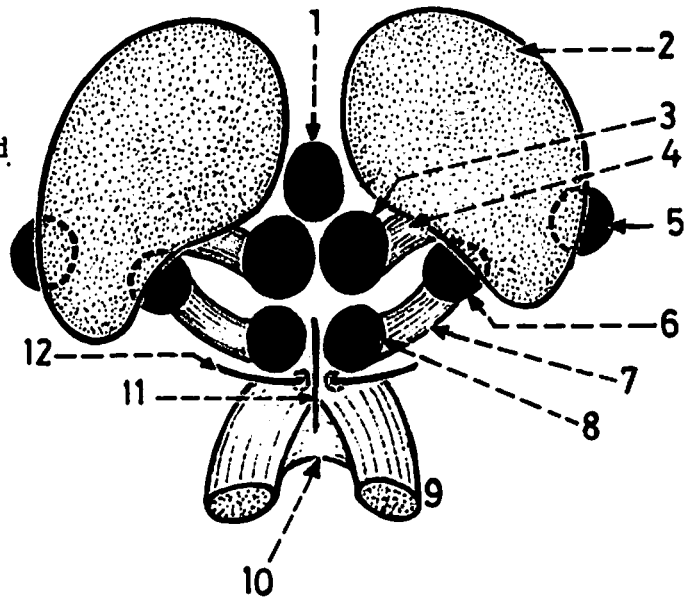
Fig.(127): RELATIONS OF THE TECTUM

The tectum is overlapped from above by the splenium of the corpus callosum, and from below by the anterior lobe of the cerebellum.

1. splenium of corpus callosum.
2. tectum of midbrain.
3. anterior lobe of cerebellum.

Fig.(128): CONNECTIONS BETWEEN THE COLLICULI AND GENICULATE BODIES

The superior colliculus is connected with the lateral geniculate body by the brachium of superior colliculus, while the inferior colliculus is connected with the medial geniculate body by the brachium of inferior colliculus. These brachia are elevated ridges consisting of fibres.



1. pineal body.
2. thalamus.
3. superior colliculus.
4. brachium of superior colliculus.
5. lateral geniculate body.
6. medial geniculate body.
7. brachium of inferior colliculus.
8. inferior colliculus.
9. superior cerebellar peduncle.
10. superior medullary velum (between the 2 cerebellar peduncles).
11. frenulum veli (a ridge of white matter extending from the sulcus between the 2 inferior colliculi to the superior medullary velum).
12. trochlear nerve (emerges on the side of the frenulum just below the inferior colliculus).

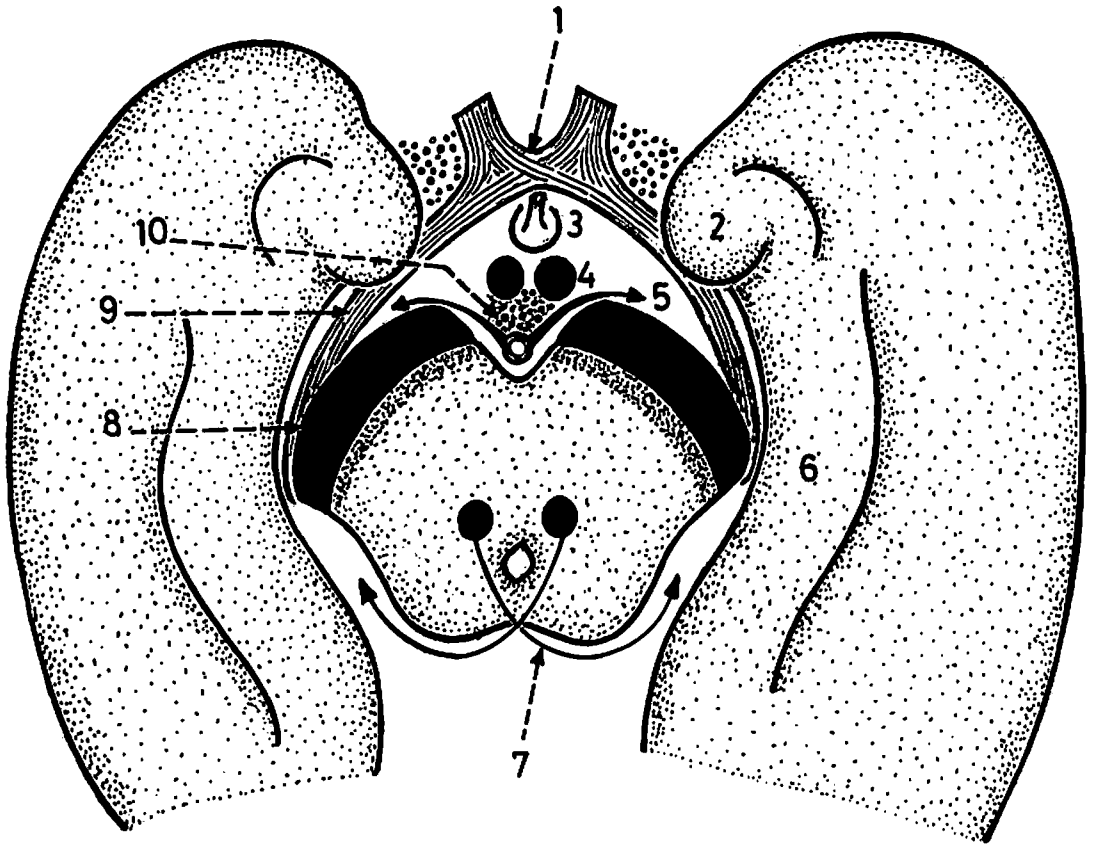


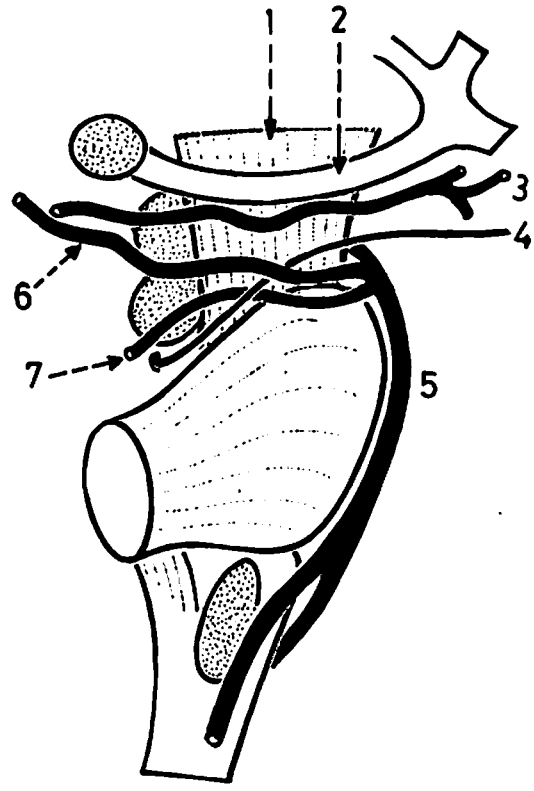
Fig.(129): RELATIONS IN FRONT AND ON EACH SIDE OF THE MIDBRAIN

The midbrain is related in front to the contents of the interpeduncular fossa (posterior cerebral arteries, posterior perforated substance and mamillary bodies), and is related on each side to the free margin of the tentorium cerebelli, the parahippocampal gyrus of the temporal lobe, optic tract and trochlear nerve.

1. optic chiasma.
2. uncus of the temporal lobe.
3. tuber cinereum and infundibulum.
4. mamillary bodies.
5. arrow representing the posterior cerebral artery.
6. parahippocampal gyrus.
7. trochlear nerve emerging on the back of the midbrain.
8. crus cerebri.
9. optic tract.
10. posterior perforated substance.

* For more relations of the crus cerebri, see fig.(130).

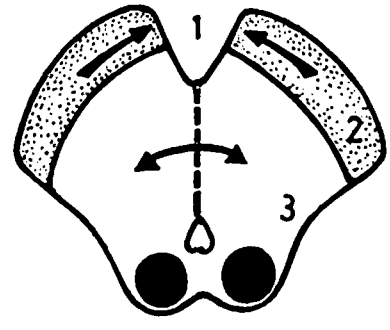
Fig.(130): STRUCTURES CROSSING THE LATERAL SURFACE OF THE CRUS CEREBRI



These are the optic tract (above), the trochlear nerve (below) and 2 blood vessels in between (posterior cerebral artery and basal vein).

1. lateral surface of the crus cerebri.
2. optic tract (uppermost and runs from before backwards).
3. basal vein (runs from before backwards).
4. trochlear nerve (lowermost and runs from behind forwards).
5. basilar artery.
6. posterior cerebral artery (runs from before backwards).
7. superior cerebellar artery.

Fig.(131): THE 2 CRURA ARE SEPARATED FROM EACH OTHER



The 2 crura are separated from each other anteriorly by the interpeduncular fossa. This is in contrast to the tegmentum where the right and left halves are continuous with each other.

1. interpeduncular fossa.
2. crus cerebri.
3. tegmentum.

INTERNAL STRUCTURE OF MIDBRAIN

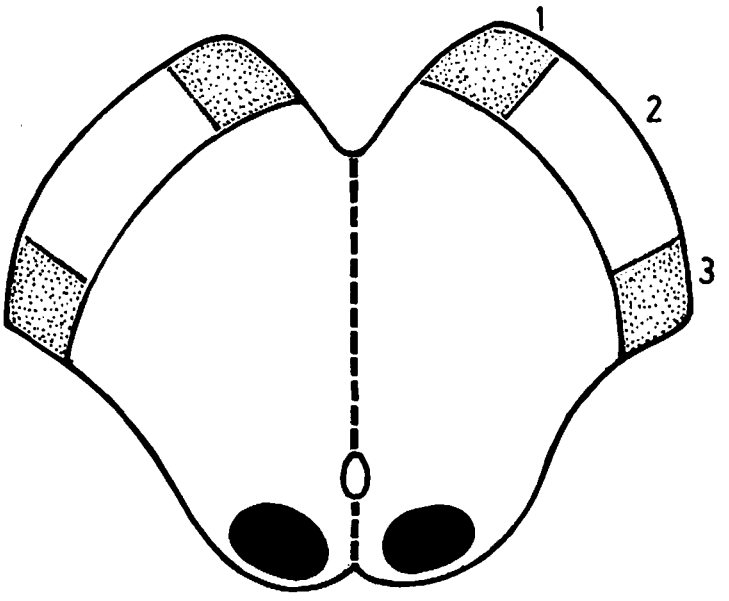


Fig.(132): CRUS CEREBRI

It is a thick band of descending nerve fibres which forms the anterior part of the cerebral peduncle. These fibres are pyramidal (corticonuclear and corticospinal) and cortico-pontine.

1. frontopontine fibres: occupy the medial 1/5 of the crus (from the frontal cortex to the pontine nuclei).
2. pyramidal fibres: occupy the middle 3/5 of the crus and consist of both cortico-nuclear and corticospinal fibres. The corticonuclear fibres lie medial to the corticospinal fibres.
3. temporopontine, parieto-pontine and occipitopontine fibres: occupy the lateral 1/5 of the crus (from the temporal, parietal and occipital lobes to the pontine nuclei).

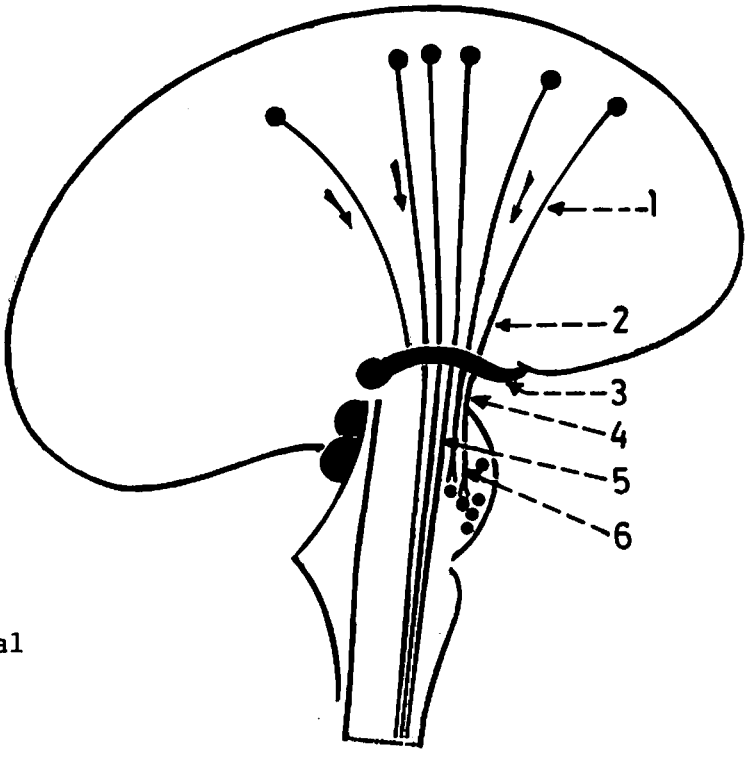


Fig.(133): PYRAMIDAL AND CORTICOPONTINE FIBRES

These are descending fibres which arise from the cerebral cortex and end below on the pontine nuclei (corticopontine), on the nuclei of cranial nerves (corticonuclear) and on the anterior horn cells of the spinal cord (corticospinal).

1. descending fibres in the corona radiata.
2. descending fibres in the internal capsule.
3. optic tract (demarcates the junction between the internal capsule and crus cerebri).
4. crus cerebri.
5. pyramidal fibres.
6. corticopontine fibres.

Fig.(134): DESCENDING FIBRES IN THE CRUS CEREBRI

1. fibres in the crus cerebri.
2. corticopontine fibres: to the pontine nuclei.
3. corticospinal fibres: to the anterior horn cells of the spinal cord.
4. corticonuclear (corticobulbar) fibres: to the nuclei of cranial nerves.
5. pontocerebellar fibres.

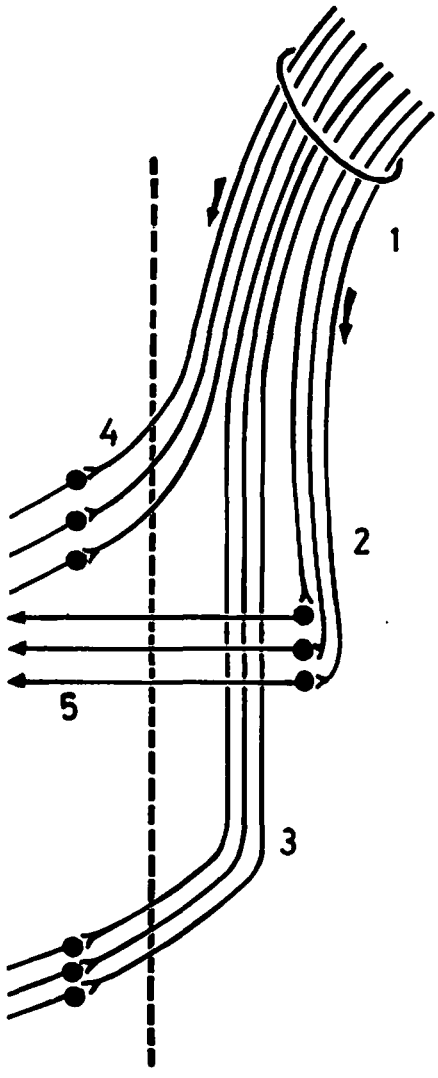


Fig.(135): POSITION OF THE PYRAMIDAL FIBRES IN THE BRAINSTEM

The pyramidal fibres (corticonuclear and corticospinal) lie on the ventral aspect of the brainstem. In the midbrain they occupy the crus cerebri, in the pons they occupy its basilar part, and in the medulla oblongata they occupy the pyramid.

1. pyramidal fibres in the crus cerebri.
2. pyramidal fibres in the basilar part of pons.
3. pyramidal fibres in the pyramid of the medulla oblongata.

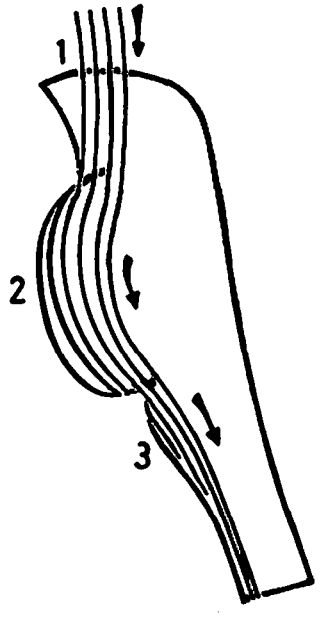
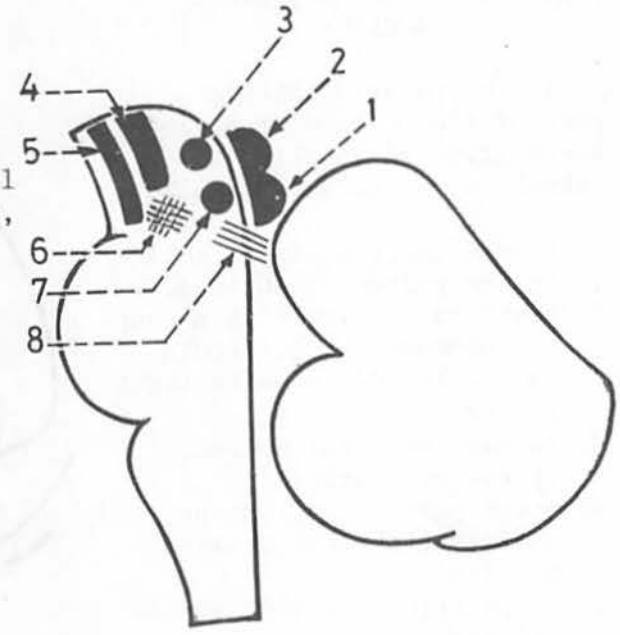


Fig.(136): THE 2 LEVELS OF MIDBRAIN

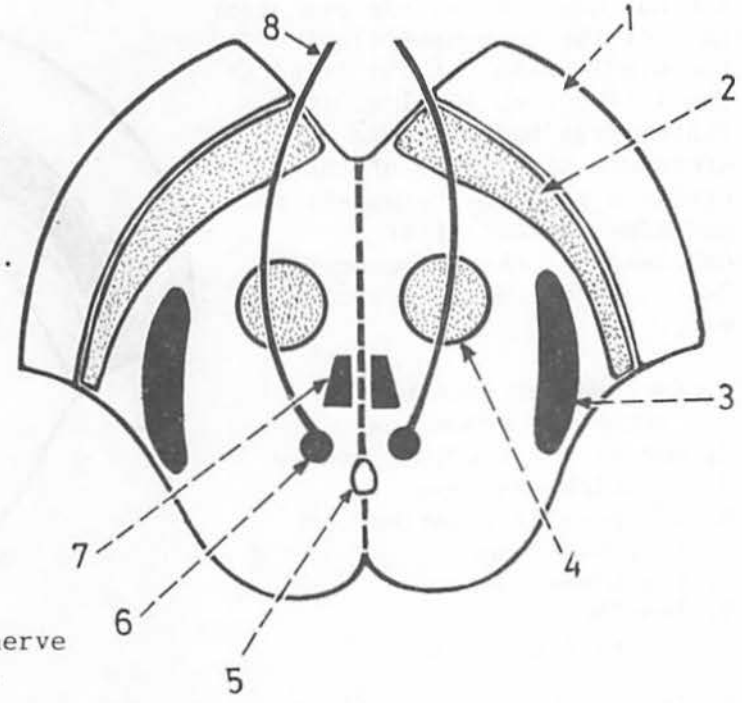


There are 2 levels in the midbrain: an upper level opposite the superior colliculus, and a lower level opposite the inferior colliculus. In the upper level lie the oculomotor nucleus and red nucleus, while in the lower level lie the the trochlear nucleus and decussation of the superior cerebellar peduncles.

1. inferior colliculus.
2. superior colliculus.
3. oculomotor nucleus.
4. red nucleus.
5. substantia nigra (extends throughout the whole midbrain).
6. decussation of superior peduncles.
7. trochlear nucleus.
8. superior cerebellar peduncle.

* Note for comparison: the closed medulla has a lower level corresponding to the motor decussation, and an upper level corresponding to the sensory decussation. Similarly, the pons has a lower level corresponding to the trapezoid body, and an upper level corresponding to the lateral lemniscus.

Fig.(137): COURSE OF OCULOMOTOR NERVE IN THE MIDBRAIN



Its nucleus lies in the posterior part of the tegmentum close to the midline, at the level of the superior colliculus. Its fibres pass forwards to emerge on the medial surface of the crus cerebri. They traverse the red nucleus and medial part of the substantia nigra.

1. crus cerebri.
2. substantia nigra.
3. lemnisci.
4. red nucleus.
5. cerebral aqueduct.
6. oculomotor nucleus.
7. medial longitudinal bundle.
8. emerging fibres of oculomotor nerve (in the interpeduncular fossa).

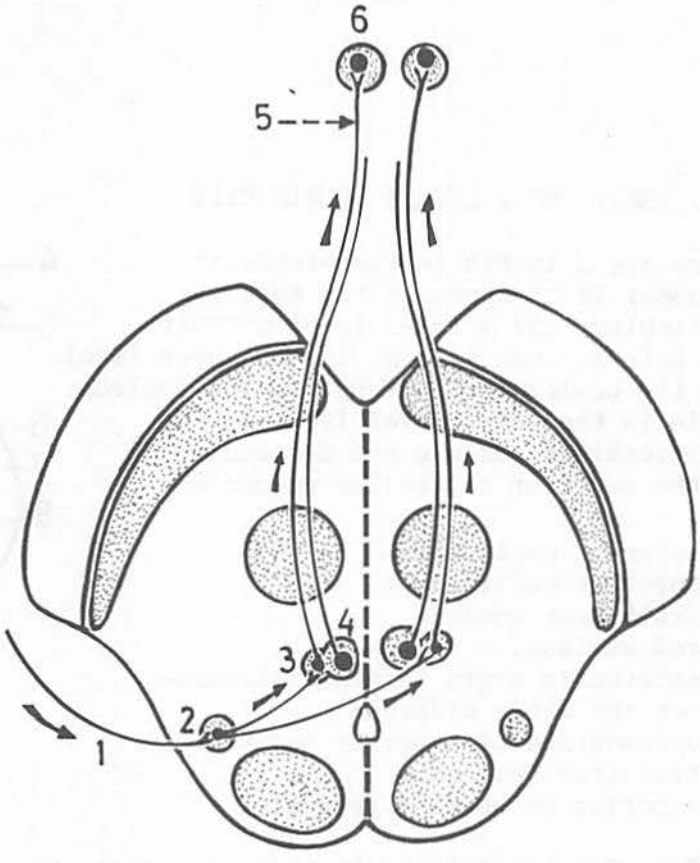


Fig.(138): EDINGER-WESTPHAL NUCLEUS

It is the parasympathetic part of the oculomotor nucleus which gives preganglionic fibres to the ciliary ganglion.

1. fibres carrying light reflex to the pretectal nucleus.
2. pretectal nucleus: lies deep to the superior colliculus and is associated with light reflex.
3. Edinger-Westphal nucleus (parasympathetic).
4. motor part of oculomotor nucleus (to extra-ocular muscles).
5. preganglionic fibres to the ciliary ganglion.
6. ciliary ganglion.

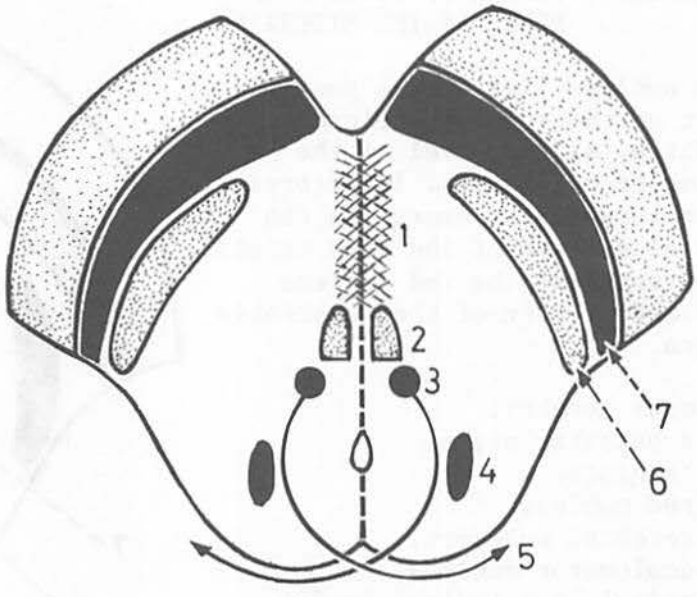


Fig.(139): COURSE OF THE TROCHLEAR NERVE IN THE MIDBRAIN

Its nucleus lies in the posterior part of the tegmentum close to the middle line, at the level of the inferior colliculus. Its fibres pass backwards to decussate with those of the opposite side in the superior medullary velum. After decussation, the nerve emerges just lateral to the frenulum veli.

1. decussation of superior cerebellar peduncles.
2. medial longitudinal bundle.
3. trochlear nucleus.
4. mesencephalic nucleus of trigeminal nerve.
5. trochlear nerve.
6. lemnisci.
7. substantia nigra.

* The trochlear nerve is the only cranial nerve which emerges on the back of the brainstem.

Fig.(140): CONNECTIONS OF RED NUCLEUS

The red nucleus lies in the upper part of the tegmentum of the midbrain and is one of the extrapyramidal centres. It receives afferent fibres mainly from the cerebral cortex, corpus striatum, subthalamic nucleus and dentate nucleus of the cerebellum. It sends efferent fibres in the form of rubrospinal and rubrobulbar tracts.

1. cerebral cortex.
2. globus pallidus of lentiform nucleus.
3. subthalamic nucleus.
4. red nucleus.
5. decussation of the rubrospinal fibres in the ventral tegmental decussation.
6. dentate nucleus of the cerebellum.
7. rubrospinal and rubrobulbar fibres.

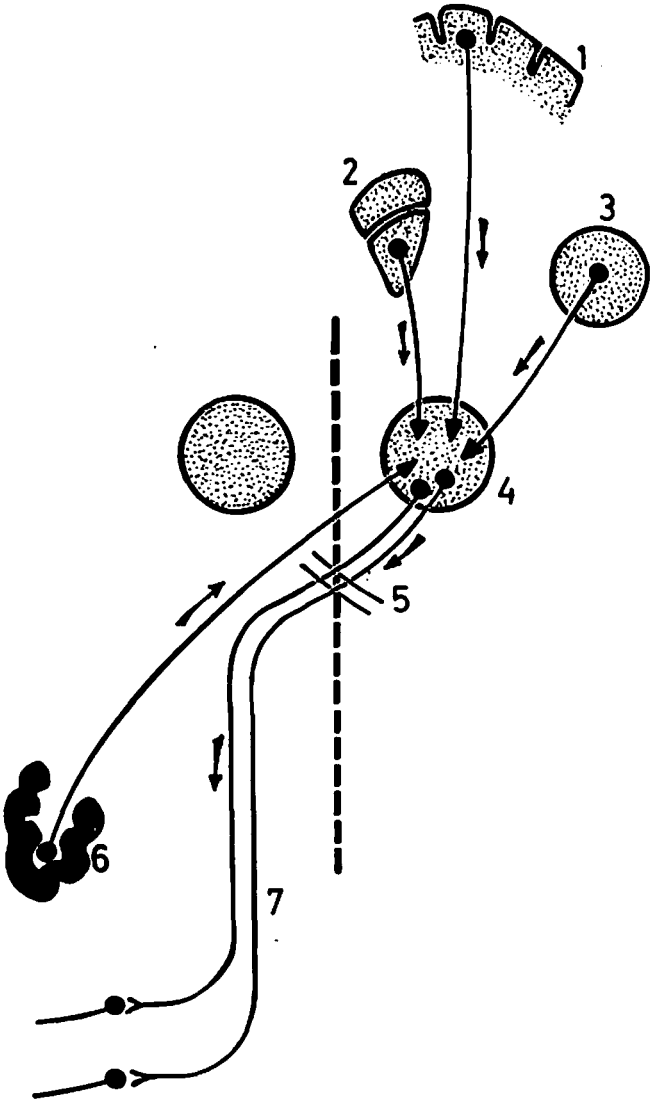


Fig.(141): VENTRAL AND DORSAL TEGMENTAL DECUSSATIONS

These 2 decussations lie in the upper part of the tegmentum of the midbrain. The ventral tegmental decussation lies ventral to the red nucleus and is formed by the rubrospinal fibres. The dorsal tegmental decussation lies dorsal to the red nucleus and is formed by the tectospinal fibres.

1. superior colliculus.
2. dorsal tegmental decussation.
3. red nucleus.
4. ventral tegmental decussation.

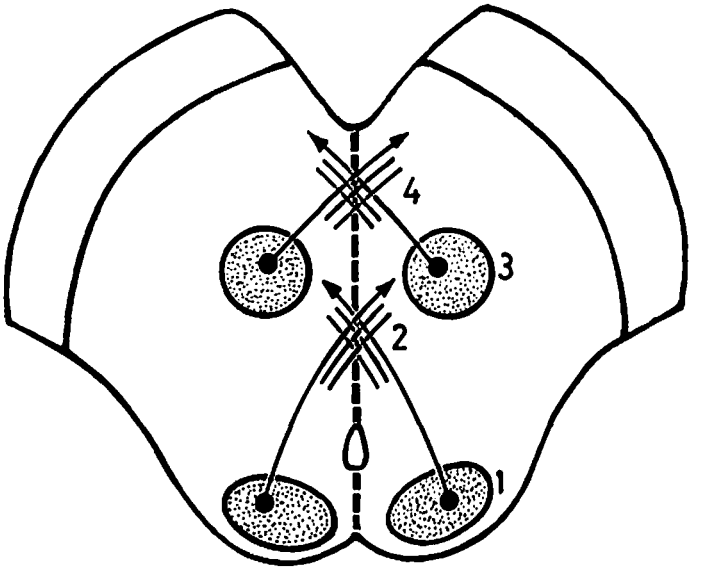
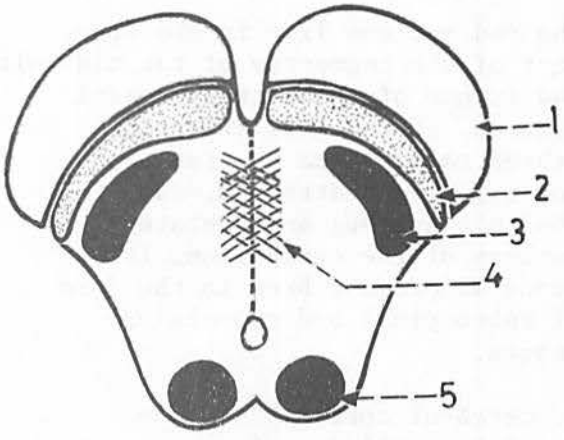


Fig.(142): DECUSSATION OF THE SUPERIOR CEREBELLAR PEDUNCLES



The 2 superior cerebellar peduncles pierce the back of the midbrain just below the inferior colliculi to decussate in the ventral part of the tegmentum. This decussation of superior peduncles lies in the lower part of the midbrain.

1. crus cerebri.
2. substantia nigra.
3. the 4 lemnisci (form a band of fibres just behind the substantia nigra).
4. decussation of superior cerebellar peduncles (in the lower part of midbrain).
5. inferior colliculus.

* Note that the decussation of the superior peduncles lies in the lower part of midbrain, while the ventral and dorsal tegmental decussations lie in the upper part of midbrain.

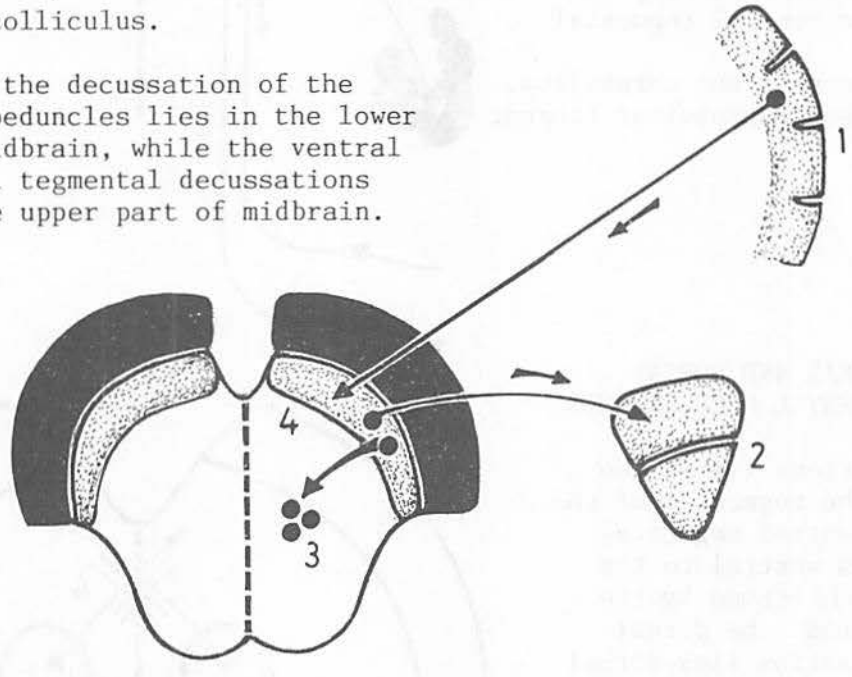


Fig.(143): CONNECTIONS OF SUBSTANTIA NIGRA

The substantia nigra is an extrapyramidal centre which receives afferent fibres mainly from the cerebral cortex, and sends efferent fibres mainly to the corpus striatum and reticular nuclei in the tegmentum of the midbrain.

1. cerebral cortex.
2. corpus striatum.
3. reticular nuclei of midbrain.
4. substantia nigra.

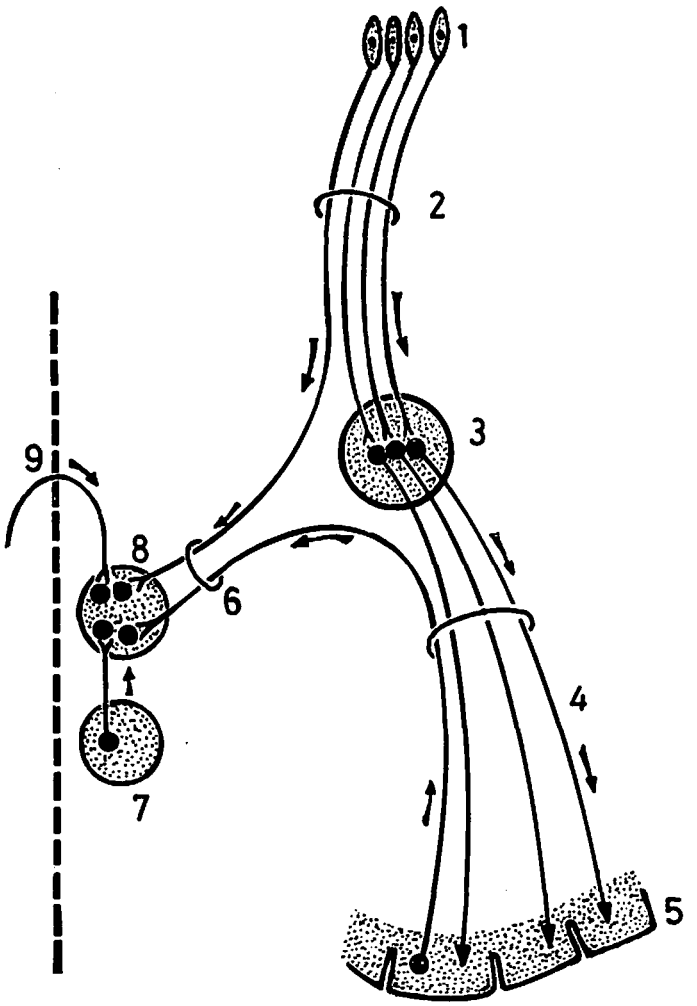


Fig.(144): AFFERENT FIBRES TO THE SUPERIOR COLLICULUS

These afferents come from the retina, occipital cortex, inferior colliculus and spinal cord.

1. retina.
2. optic tract.
3. lateral geniculate body.
4. optic radiation.
5. occipital cortex.
6. brachium of superior colliculus (consists of afferents from the retina and occipital cortex).
7. inferior colliculus.
8. superior colliculus.
9. spinotectal fibres from the spinal cord.

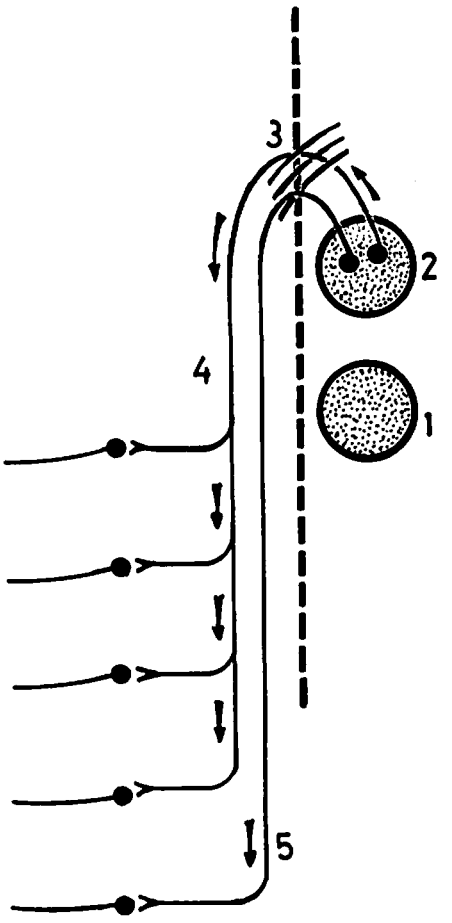


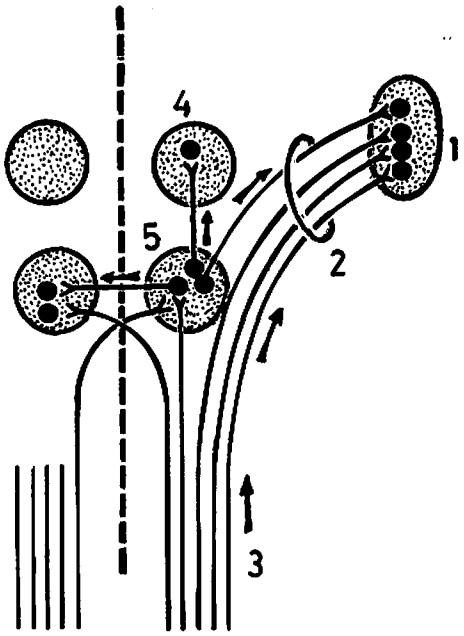
Fig.(145): EFFERENT FIBRES FROM THE SUPERIOR COLLICULUS

These efferents form the tectobulbar fibres to the brainstem and tectospinal fibres to the spinal cord.

1. inferior colliculus.
2. superior colliculus.
3. decussation of the tectospinal and tectobulbar fibres in the dorsal tegmental decussation.
4. tectobulbar fibres to nuclei of the cranial nerves.
5. tectospinal fibres to the anterior horn cells of the spinal cord.

* The superior colliculus is a reflex centre for vision.

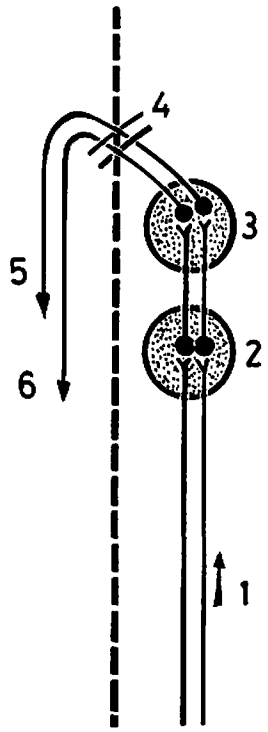
Fig.(146): CONNECTIONS OF THE INFERIOR COLLICULUS



The inferior colliculus is a reflex centre for hearing. It receives afferent fibres from the lateral lemniscus, and sends efferent fibres mainly to the medial geniculate body and superior colliculus.

1. medial geniculate body.
2. brachium of inferior colliculus (consists of fibres from the inferior colliculus and lateral lemniscus to the medial geniculate body).
3. lateral lemniscus.
4. superior colliculus.
5. inferior colliculus.

Fig.(147): CONNECTIONS OF THE INFERIOR COLLICULUS WITH THE BRAINSTEM AND SPINAL CORD



The inferior colliculus sends efferents to the superior colliculus, and then through the tectobulbar and tectospinal fibres the inferior colliculus gets connected with the brainstem and spinal cord respectively.

1. lateral lemniscus (cochlear fibres).
2. inferior colliculus.
3. superior colliculus.
4. dorsal tegmental decussation.
5. tectobulbar fibres.
6. tectospinal fibres.

Fig.(148): POSITION OF THE MEDIAL LONGITUDINAL BUNDLE

This bundle consists of both ascending and descending fibres. It lies just in front of the central grey matter of the whole brainstem extending from the uppermost part of the midbrain above to the lower end of the medulla oblongata where it becomes continuous with the anterior intersegmental tract of the spinal cord. Throughout its course, this bundle lies close to the midline in close relation to the nuclei of the 3rd, 4th, 6th, and 12th nerves as well as to the internal genu of the 7th nerve.

(a) medial longitudinal bundle (M.L.B.) in the upper part of midbrain: close to the oculomotor nucleus.

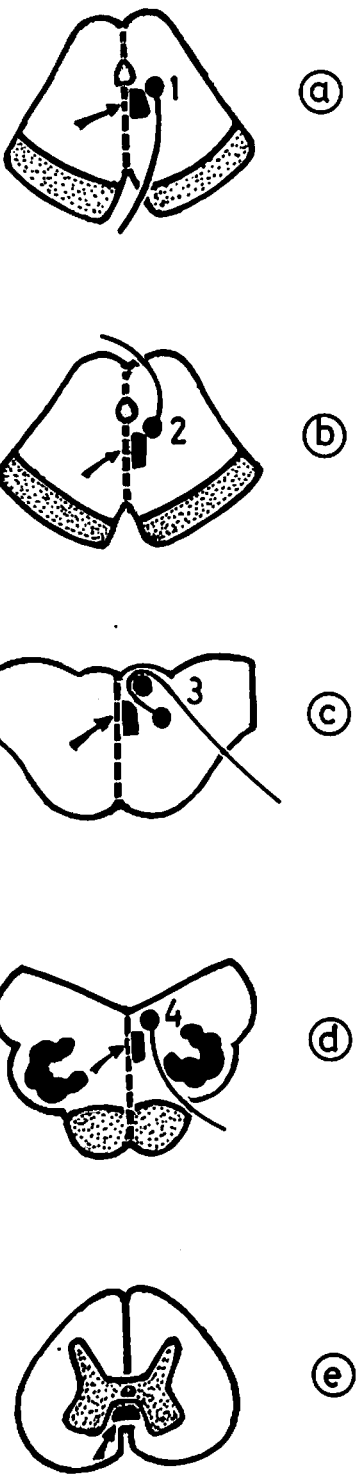
(b) M.L.B. in the lower part of the midbrain: close to the trochlear nucleus.

(c) M.L.B. in the pons: close to the abducent nucleus and genu of the facial nerve.

(d) M.L.B. in the medulla: close to the hypoglossal nucleus.

(e) anterior intersegmental tract of spinal cord: downward extension of the M.L.B.

1. nucleus of oculomotor nerve.
2. nucleus of trochlear nerve.
3. nucleus of abducent nerve and genu of facial nerve.
4. nucleus of hypoglossal nerve.



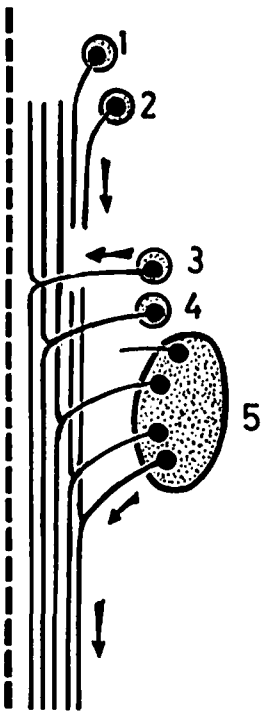


Fig.(149): AFFERENT FIBRES TO THE MEDIAL LONGITUDINAL BUNDLE

At its beginning, the M.L.B. gets fibres from the interstitial nucleus of Cajal and nucleus of the posterior commissure. It receives afferent fibres from all vestibular nuclei, nucleus of lateral lemniscus and nuclei of trapezoid body. This means that its afferents are vestibular and cochlear fibres.

1. interstitial nucleus of Cajal.
2. nucleus of posterior commissure.
3. nucleus of lateral lemniscus.
4. nuclei of trapezoid body.
5. vestibular nuclei (main source).

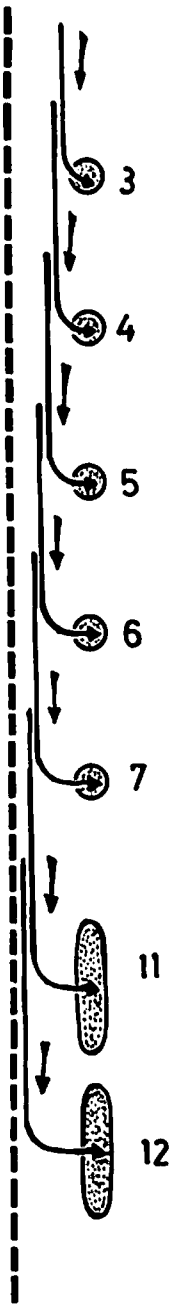
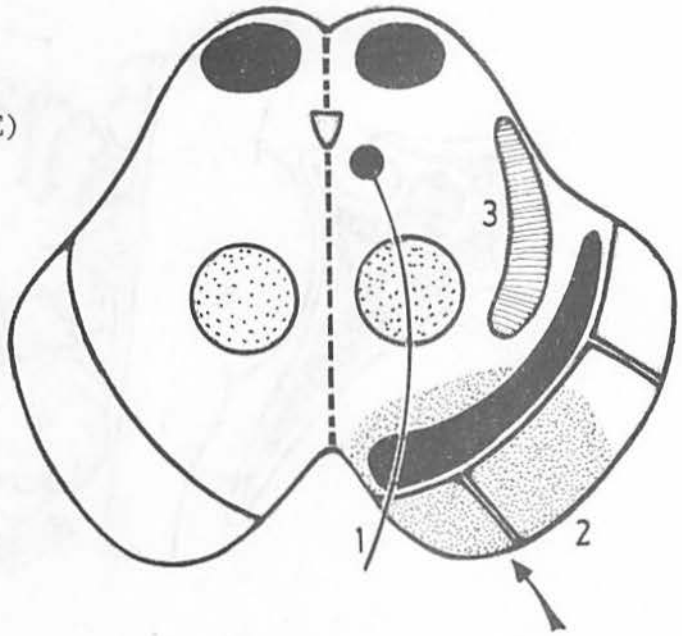


Fig.(150): EFFERENT FIBRES FROM THE MEDIAL LONGITUDINAL BUNDLE

Efferents from the M.L.B. reach the nuclei of the 3rd, 4th, 5th, 6th, 7th, 11th and 12th cranial nerves. These connections are responsible for coordination of the movements of the muscles supplied by these cranial nerves in response to vestibular and cochlear impulses.

LESIONS OF THE MIDBRAIN

Fig.(151): LESION TO THE CRUS CEREBRI (WEBER'S SYNDROME)

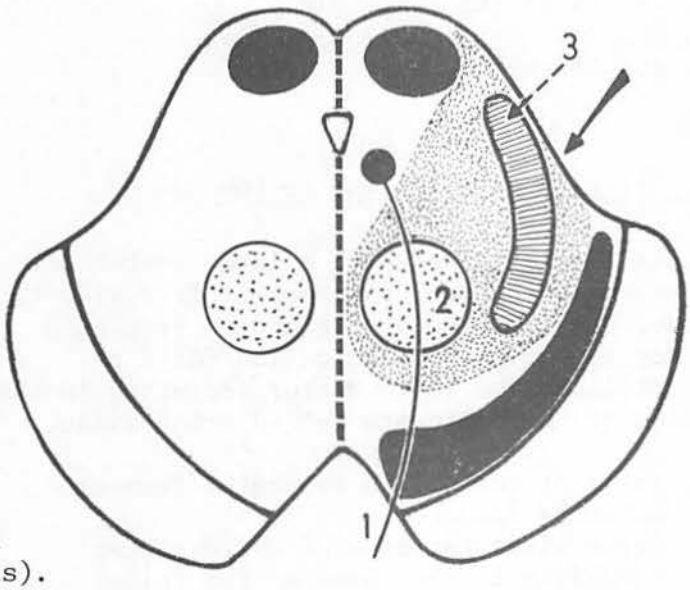


There is damage to the pyramidal fibres leading to contralateral hemiplegia, and to the emerging fibres of the oculomotor nerve leading to paralysis of the extraocular muscles supplied by this nerve.

1. oculomotor nerve.
2. crus cerebri.
3. lemnisci.

* In this lesion, there is no sensory affection because the lemnisci are intact.

Fig.(152): LESION TO THE TEGMENTUM OF MIDBRAIN (BENEDIKT'S SYNDROME)



There is damage to the lemnisci leading to loss of all general sensations on the opposite side of the body including the face. There is also damage to the emerging fibres of the oculomotor nerve leading to paralysis of the extra-ocular muscles on the same side as the lesion, and to the red nucleus leading to rigidity and tremors.

1. oculomotor nerve.
2. red nucleus.
3. the lemnisci (medial, trigeminal and spinal, from before backwards).

* In this lesion, the pyramidal tract is intact.

CEREBELLUM

GROSS MORPHOLOGY

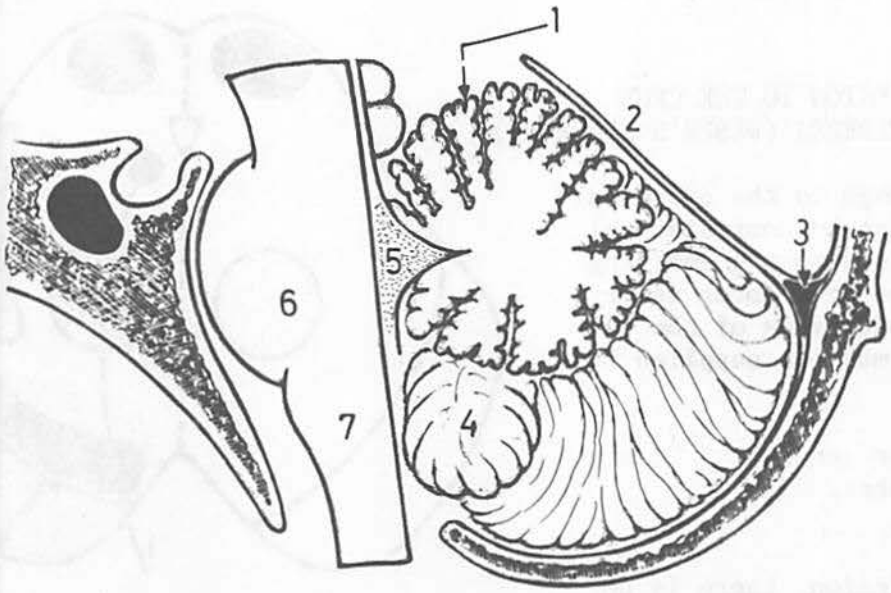


Fig.(153): POSITION OF THE CEREBELLUM

It lies in the posterior cranial fossa under cover of the tentorium cerebelli, and behind the pons and medulla oblongata from which it is separated by the cavity of the 4th ventricle.

1. cerebellum in median section.
2. tentorium cerebelli.
3. confluence of venous sinuses.
4. tonsil of cerebellum.
5. cavity of 4th ventricle.
6. pons.
7. medulla oblongata.

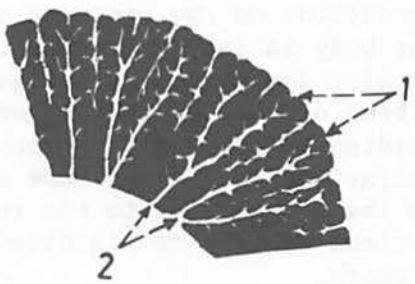


Fig.(154): CORTEX OF THE CEREBELLUM

It is highly folded with a large number of fissures which run transversely from side to side. The fissures are separated from each other by elevated bands called folia of cerebellum. The white matter radiating in the cores of the folia are called arbor vitae.

1. folia of cerebellum separated from each other by fissures.
2. arbor vitae (strands of white matter spreading in the cores of the folia).

* The cortex of the cerebellum consists of folia and fissures, while the cortex of the cerebrum consists of gyri and sulci.

Fig.(155): PARTS OF THE CEREBELLUM

The cerebellum consists of 2 hemispheres connected together by a median part called the vermis. The cerebellum has an anterior notch and a posterior notch.

1. anterior notch.
2. right cerebellar hemisphere.
3. posterior notch.
4. left cerebellar hemisphere.
5. superior vermis.

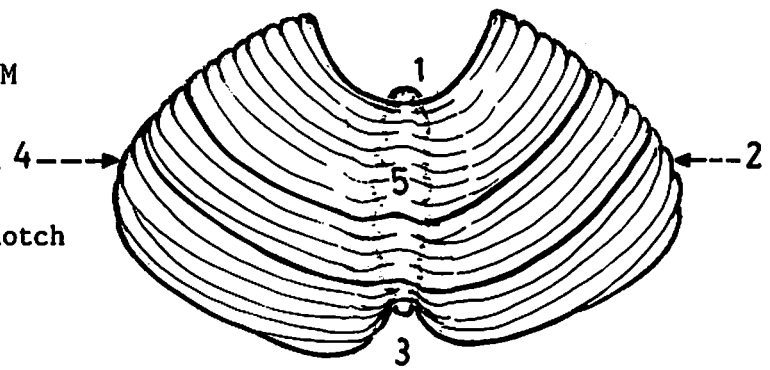


Fig.(156): STRUCTURES OCCUPYING THE CEREBELLAR NOTCHES

1. the anterior notch is occupied by the back of the brainstem.
2. the posterior notch is occupied by the falx cerebelli.

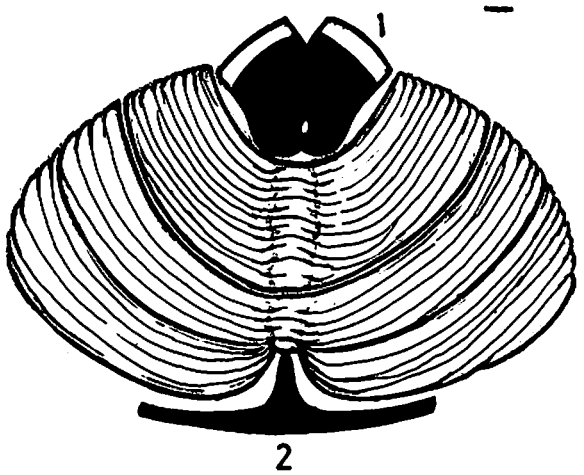
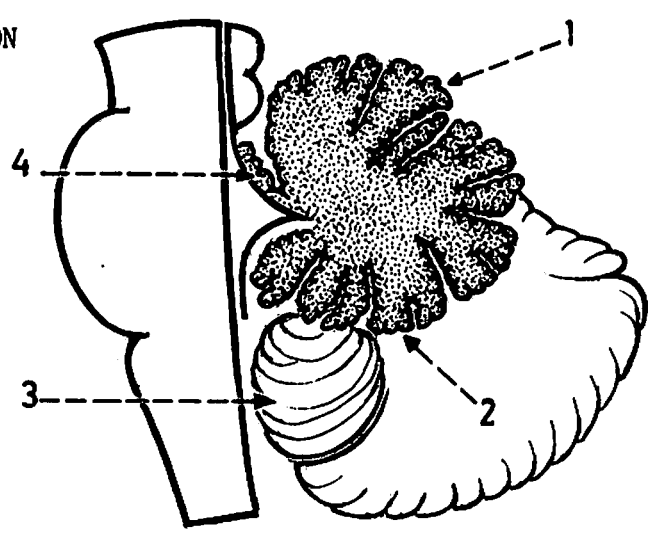


Fig.(157): CEREBELLUM IN MEDIAN SECTION TO SHOW THE VERMIS

A median section of the cerebellum cuts into the vermis. The part of the vermis seen on the superior surface of the cerebellum forms the superior vermis, while its part seen on the inferior surface forms the inferior vermis.

1. superior vermis.
2. inferior vermis.
3. tonsil of cerebellum.
4. lingula (lies on the superior medullary velum).



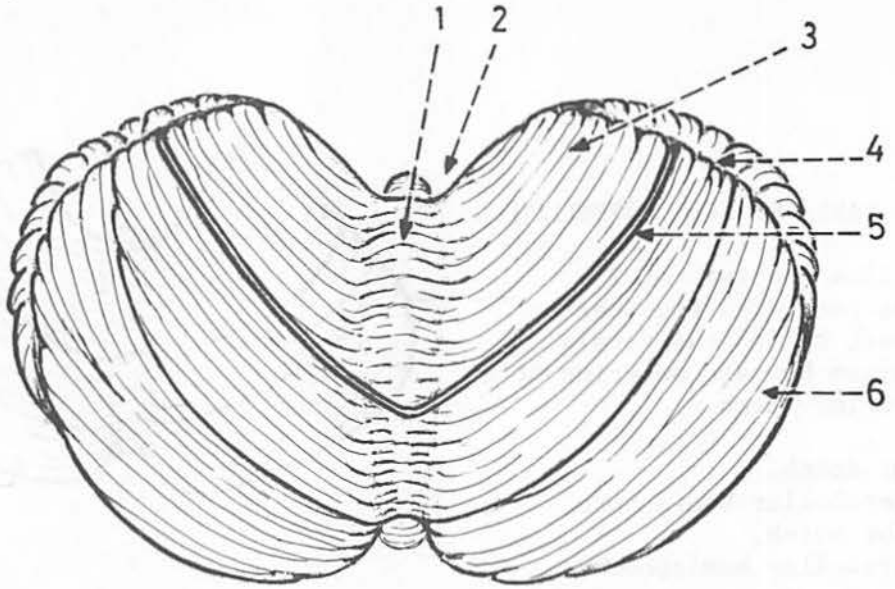


Fig.(158): SUPERIOR SURFACE OF THE CEREBELLUM

It shows the fissura prima which is V-shaped and separates the anterior lobe (in front) from the middle lobe (behind). It cuts into the superior vermis at the junction between the anterior 2/3 amd the posterior 1/3.

1. superior vermis.
2. anterior notch of cerebellum.
3. anterior lobe (in front of the fissura prima).
4. horizontal fissure (separates the superior surface from the inferior surface).
5. fissura prima.
6. superior surface of the middle lobe.

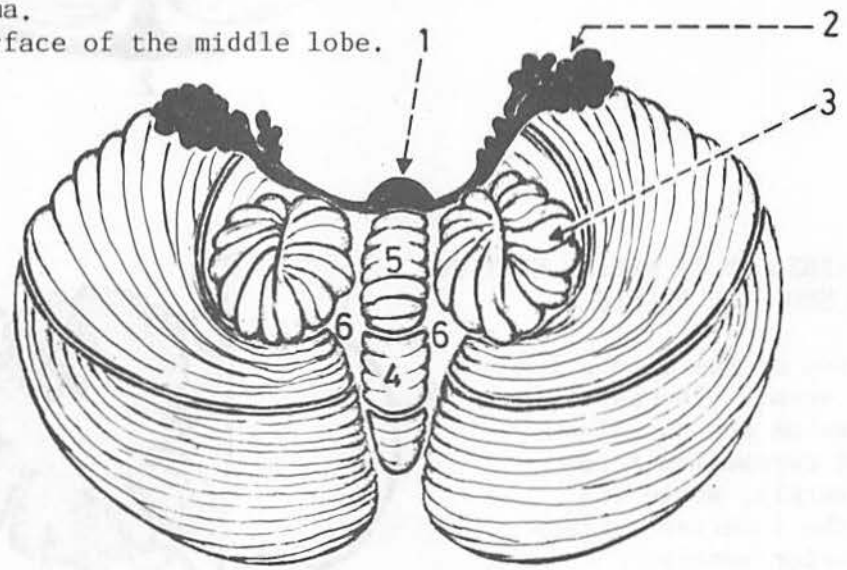


Fig.(159): INFERIOR SURFACE OF THE CEREBELLUM

It shows a median anteroposterior depression called the vallecula cerebelli in which the inferior vermis lies. On each side of the vermis lies a circumscribed mass called tonsil.

1. nodule.
2. flocculus.
3. tonsil.
4. pyramid.
5. uvula.
6. vallecula cerebelli.

* The nodule, uvula and pyramid are parts of the inferior vermis.

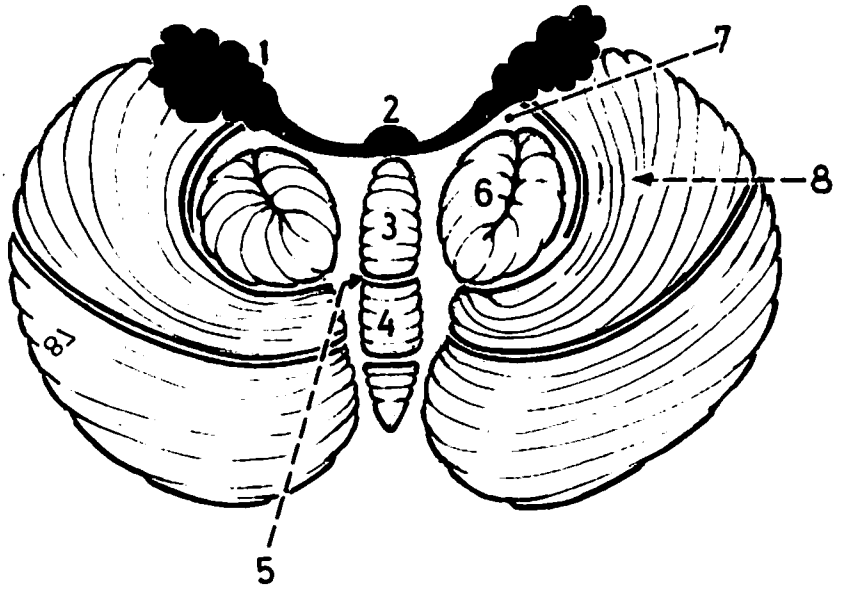


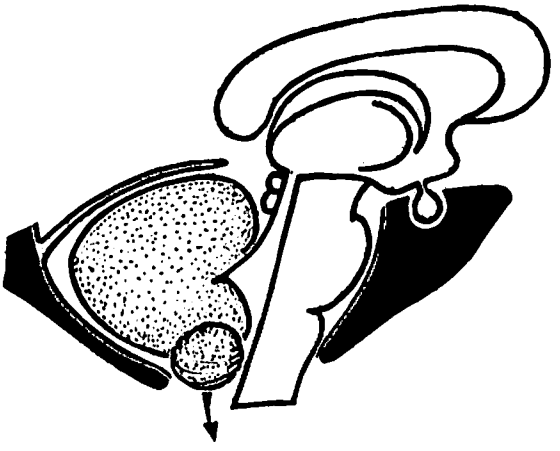
Fig.(160): FISSURES ON THE INFERIOR SURFACE OF THE CEREBELLUM

These fissures are mainly the posterolateral and postpyramidal fissures.

1. flocculus (part of the flocculonodular lobe).
2. nodule (the most anterior part of the inferior vermis).
3. uvula (the part of the inferior vermis between the 2 tonsils).
4. pyramid (behind the uvula).
5. postpyramidal fissure (fissura secunda): between the pyramid and uvula.
6. tonsil (part of the middle lobe).
7. posterolateral fissure (intervenes between the flocculonodular lobe in front and the middle lobe behind).
8. middle lobe.

* The cerebellum is formed of 3 lobes: anterior, middle and flocculonodular. The anterior lobe is seen from the superior surface and is separated from the middle lobe by the fissura prima. The flocculonodular lobe is seen from the inferior surface and is separated from the middle lobe by the posterolateral sulcus. The middle lobe is seen from the superior and inferior surfaces.

Fig.(161): HERNIATION OF THE TONSIL OF CEREBELLUM INTO THE FORAMEN MAGNUM



The tonsil of the cerebellum may herniate into the foramen magnum where it compresses the medulla oblongata.

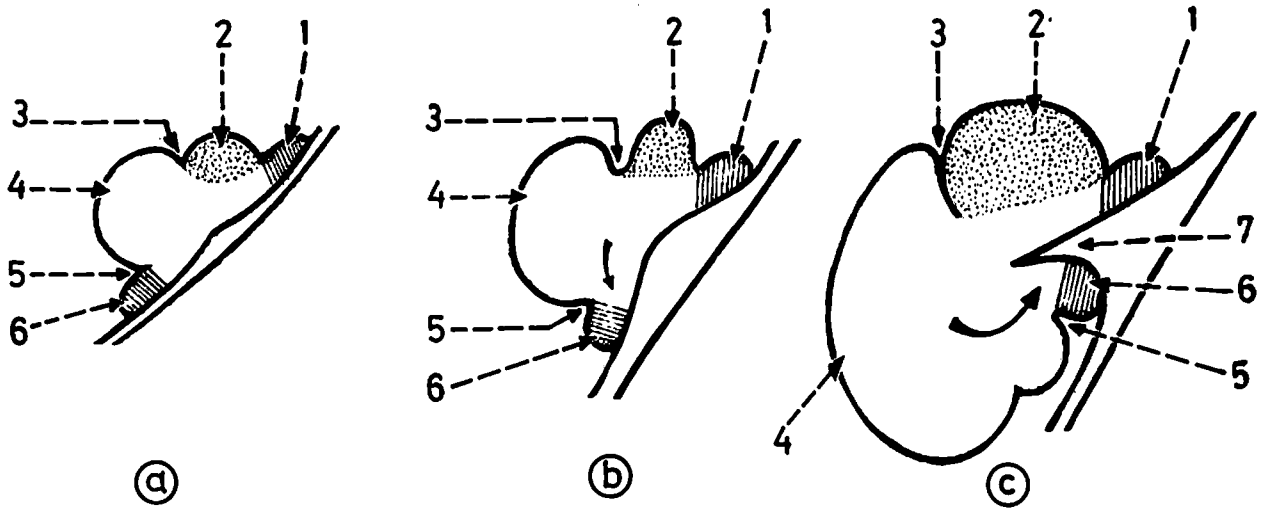


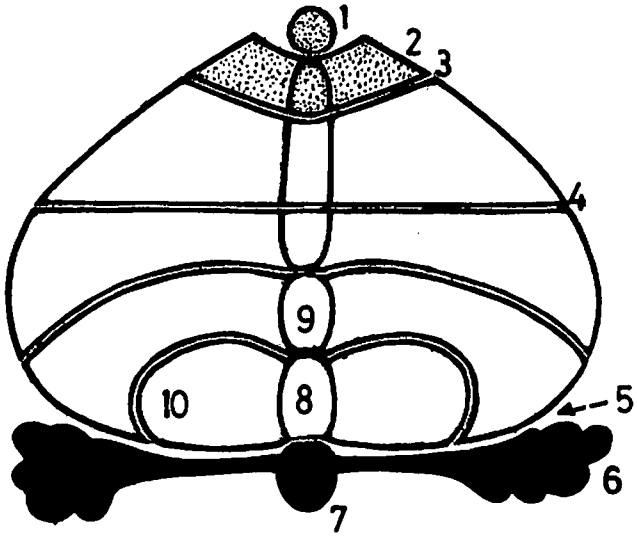
Fig.(162): FOLDING OF THE CEREBELLUM DURING INTRAUTERINE LIFE

In the early stages of development of the cerebellum, the lingula forms the most anterior part of the vermis, while the nodule forms its most posterior part. With enlargement of the middle lobe, the cerebellum becomes folded upon itself so that the nodule is pushed forwards to lie very close to the lingula with the dorsal recess of the 4th ventricle.

(a) unfolded cerebellum. (b) early stage of folding. (c) late stage of folding.

1. lingula.
2. anterior lobe.
3. fissura prima.
4. middle lobe.
5. posterolateral fissure.
6. nodule (part of the flocculonodular lobe).
7. dorsal recess of the 4th ventricle.

Fig.(163); SKETCH TO SHOW THE LOBES OF THE CEREBELLUM BEFORE FOLDING



The anterior lobe forms the anterior part, the flocculonodular lobe forms the posterior part while the middle lobe lies in between.

1. lingula (part of anterior lobe).
2. anterior lobe.
3. fissura prima.
4. horizontal fissure.
5. posterolateral fissure.
6. flocculus.
7. nodule.
8. uvula.
9. pyramid.
10. tonsil.

* The middle lobe lies between the fissura prima and the posterolateral fissure.

* The flocculonodular lobe consists of the nodule and the 2 flocculi.

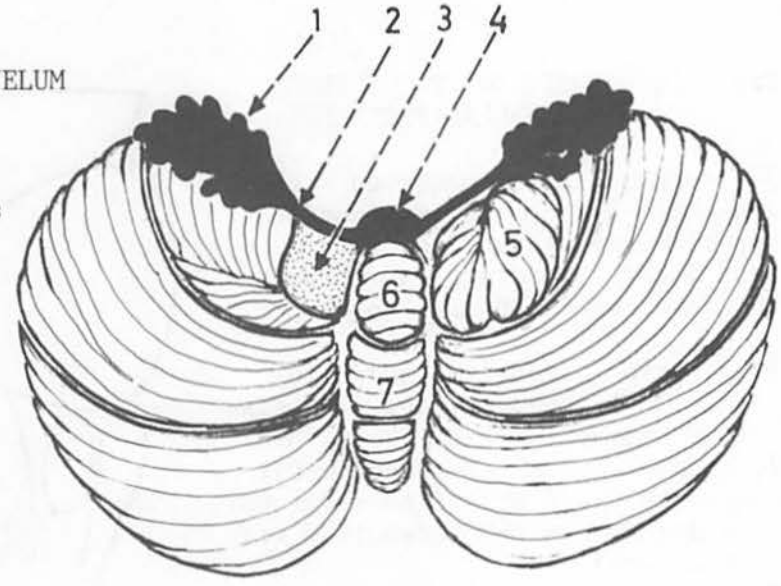


Fig.(164): INFERIOR MEDULLARY VELUM

It is a thin sheet of white matter placed one on each side of the nodule. It is continuous in front with the peduncle of the flocculus and behind with the white matter of the cerebellum. It lies deep to the tonsil forming its bed.

1. flocculus.
2. peduncle of the flocculus.
3. inferior medullary velum (exposed by removal of the tonsil).
4. nodule.
5. tonsil.
6. uvula.
7. pyramid.

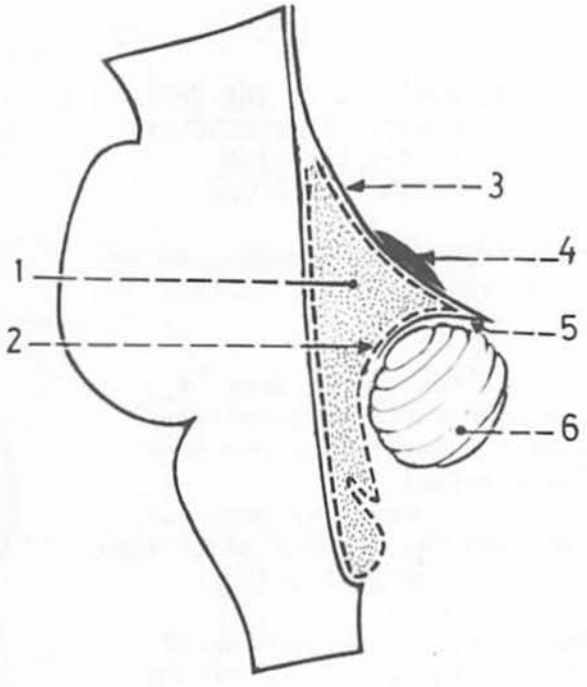


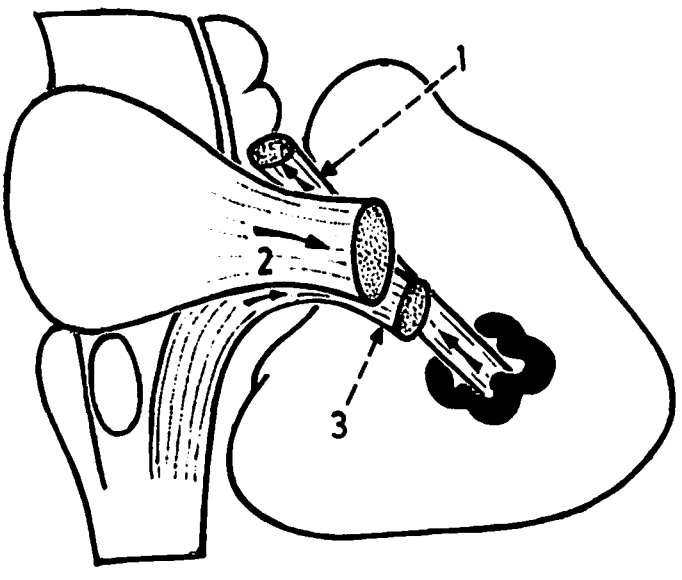
Fig.(165): SUPERIOR AND INFERIOR MEDULLARY VELA

The superior medullary velum extends between the 2 superior cerebellar peduncles forming the upper part of the roof of the 4th ventricle. The inferior medullary velum lies in the lower part of the roof of the 4th ventricle and forms a bed for the tonsil.

1. 4th ventricle.
2. ependymal lining of the 4th ventricle.
3. superior medullary velum.
4. lingula (lies over the superior medullary velum).
5. inferior medullary velum (deep to the tonsil).
6. tonsil.

CEREBELLAR PEDUNCLES

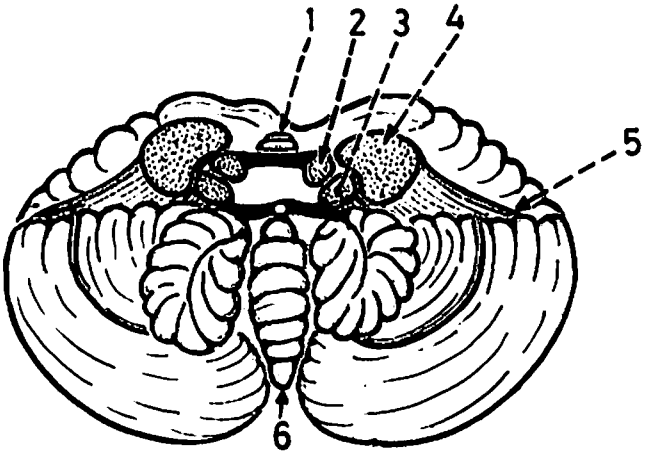
Fig.(166): POSITION OF THE THREE CEREBELLAR PEDUNCLES



The cerebellum is connected with the brainstem by 3 pairs of peduncles: superior, middle and inferior. They enter the cerebellum through the anterior cerebellar notch.

1. superior cerebellar peduncle (it is the deepest, and connects the cerebellum with the midbrain).
2. middle cerebellar peduncle (it is the thickest and most lateral, and connects the cerebellum with the pons).
3. inferior cerebellar peduncle (it begins at the middle of the medulla oblongata and passes upwards and laterally as far as the pons where it curves backwards between the middle and superior peduncles).

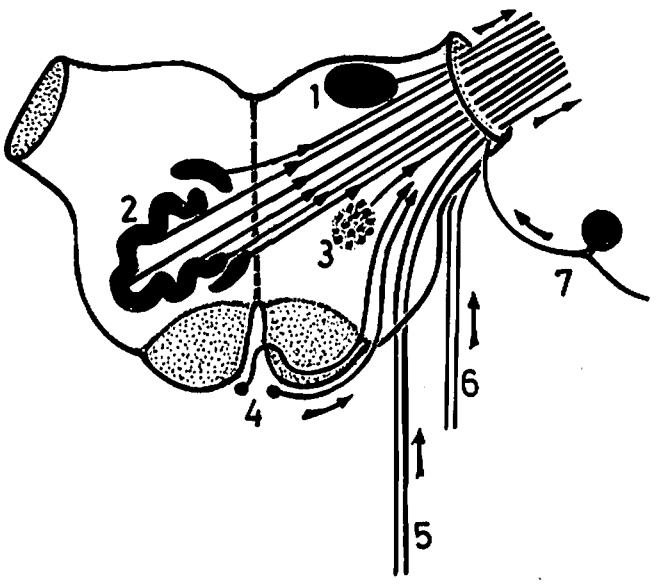
Fig.(167): POSITION OF THE THREE CEREBELLAR PEDUNCLES AT THE ANTERIOR CEREBELLAR NOTCH



In this figure the 3 peduncles are cut transversely close to the cerebellum.

1. lingula (on the surface of the superior medullary velum).
2. superior cerebellar peduncle (most medial).
3. inferior cerebellar peduncle (between the other 2 peduncles).
4. middle cerebellar peduncle (most lateral).
5. beginning of the horizontal fissure receiving the middle peduncle.
6, inferior vermis.

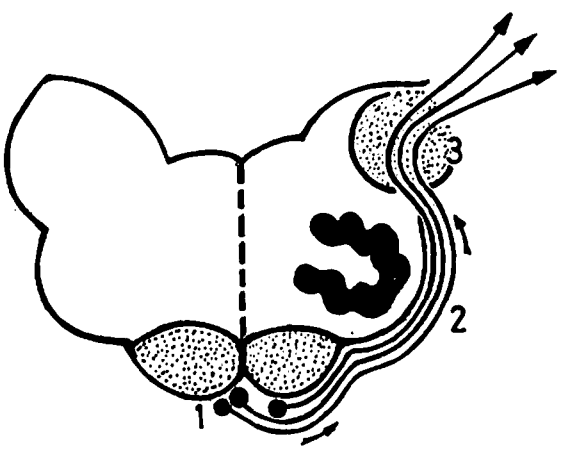
Fig.(168): INFERIOR CEREBELLAR PEDUNCLE (AFFERENT FIBRES)



Most of the afferent fibres passing through the inferior cerebellar peduncles to the cerebellum come from the medulla oblongata and spinal cord.

1. vestibulocerebellar fibres from the vestibular nuclei.
2. olivocerebellar fibres from the inferior olivary nucleus and parolivocerebellar fibres from the accessory olivary nuclei.
3. reticulocerebellar fibres from the reticular nucleus of the medulla.
4. anterior external arcuate fibres from the arcuate nuclei on the surface of the pyramid.
5. posterior spinocerebellar tract from Clarke's nucleus in the spinal cord.
6. posterior external arcuate fibres (cuneocerebellar fibres) from the accessory cuneate nucleus.
7. vestibulocerebellar fibres from the vestibular division of the vestibulocochlear nerve directly to the cerebellum.

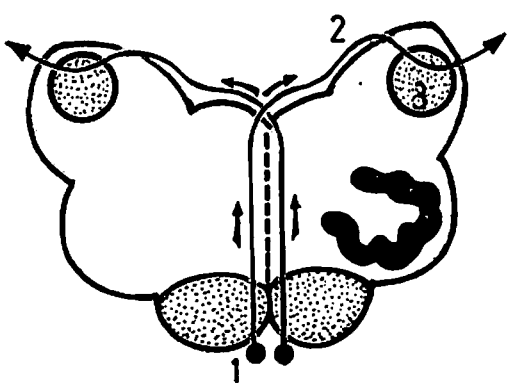
Fig.(169): ANTERIOR EXTERNAL ARCUATE FIBRES



They arise from the arcuate nuclei on the surfaces of the 2 pyramids and run laterally and upwards on the surface of the medulla to enter the inferior cerebellar peduncle.

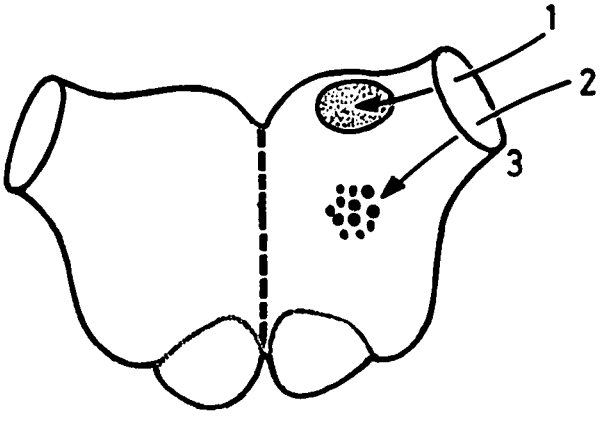
1. arcuate nuclei.
2. anterior external arcuate fibres.
3. inferior cerebellar peduncle.

Fig.(170): STRIAE MEDULLARES



1. arcuate nuclei.
2. striae medullares.
3. inferior cerebellar peduncle.

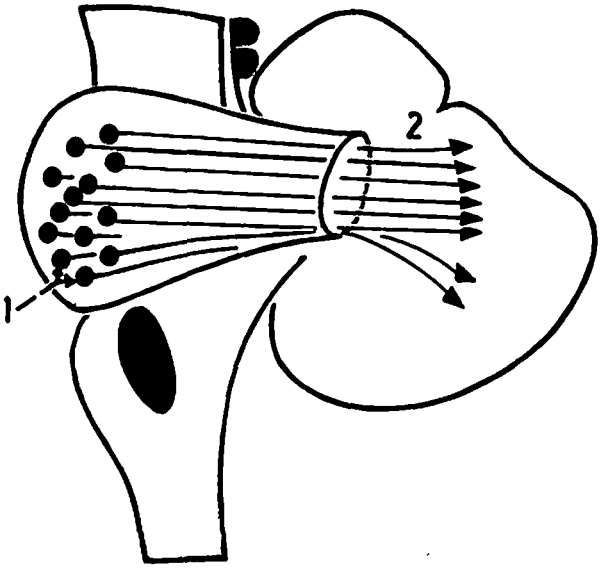
Fig.(171): INFERIOR CEREBELLAR PEDUNCLE (EFFERENT FIBRES)



These are few fibres as compared with the afferent fibres. These are the cerebellovestibular and cerebelloreticular fibres.

1. cerebellovestibular fibres to the vestibular nuclei.
2. cerebelloreticular fibres to the reticular formation in the brainstem.
3. inferior cerebellar peduncle.

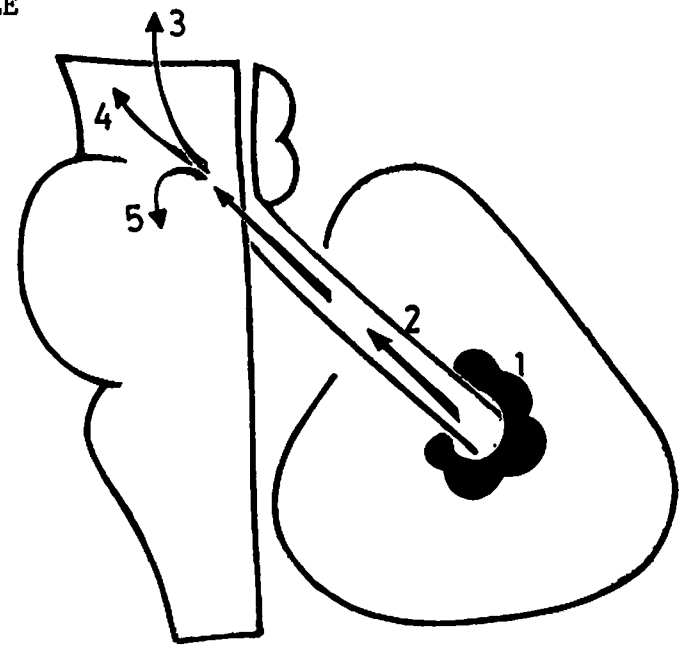
Fig.(172): FIBRES OF THE MIDDLE CEREBELLAR PEDUNCLE



All the fibres of the middle peduncle are afferents to the cerebellum. They arise from the pontine nuclei of the opposite side and are called pontocerebellar fibres.

1. pontine nuclei.
2. pontocerebellar fibres.

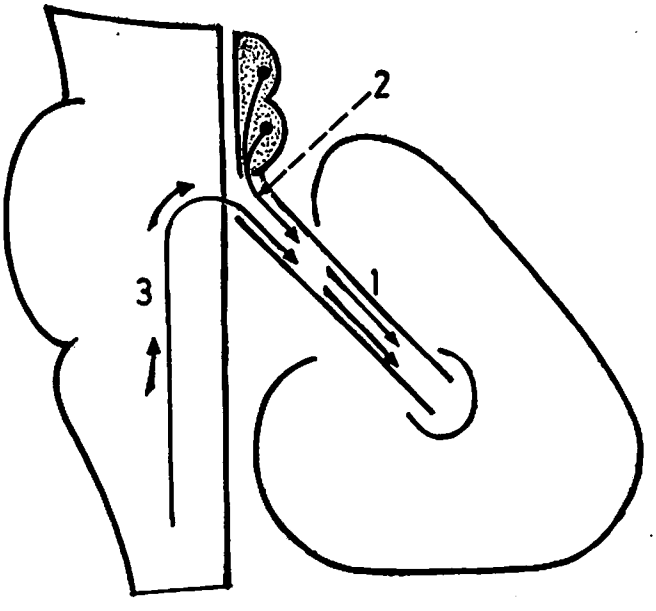
Fig.(173): SUPERIOR CEREBELLAR PEDUNCLE (EFFERENT FIBRES)



Most of the fibres of the superior peduncle are efferents arising mainly from the dentate nucleus of the cerebellum. They enter the midbrain where they are distributed to the red nucleus, thalamus, and other nuclei of the brainstem.

1. dentate nucleus of cerebellum.
2. superior cerebellar peduncle.
3. fibres to the intermediate ventral nucleus of the thalamus.
4. fibres to the red nucleus.
5. fibres descending to the olivary nucleus and reticular nuclei of the brainstem.

Fig.(174): SUPERIOR CEREBELLAR PEDUNCLE (AFFERENT FIBRES)



These are few fibres as compared with the efferent fibres. These are the anterior spinocerebellar tract and tectocerebellar tract.

1. superior cerebellar peduncle.
2. tectocerebellar tract from the tectum of midbrain.
3. anterior spinocerebellar tract from the spinal cord.

Fig.(175): DISTRIBUTION OF THE EFFERENT FIBRES OF THE SUPERIOR CEREBELLAR PEDUNCLE

1. dentate nucleus.
2. efferent fibres in the superior cerebellar peduncle.
3. decussation of the 2 superior cerebellar peduncles in the lower part of the pons.
4. intermediate ventral nucleus of thalamus.
5. red nucleus.
6. inferior olivary nucleus.
7. reticular nuclei in the brainstem.

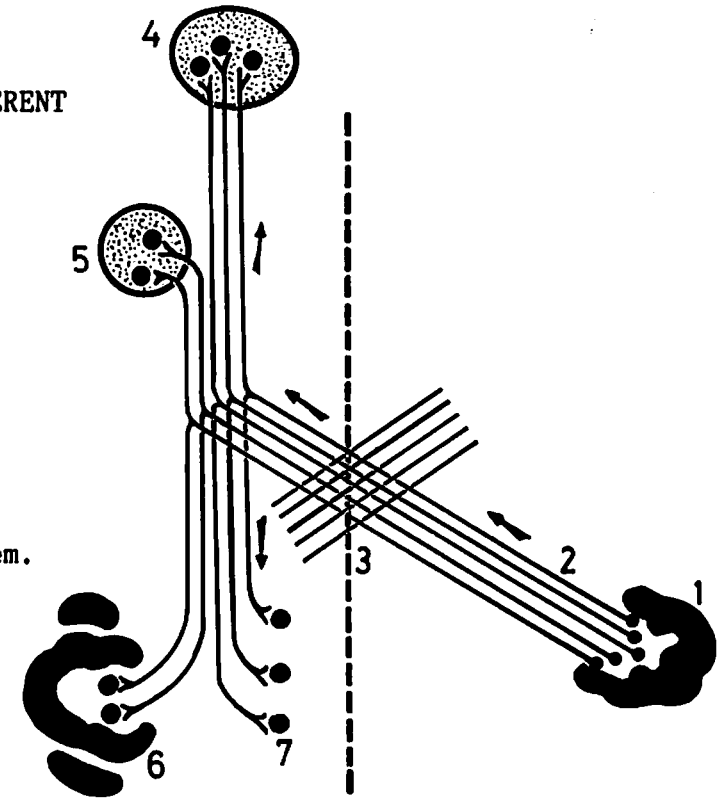
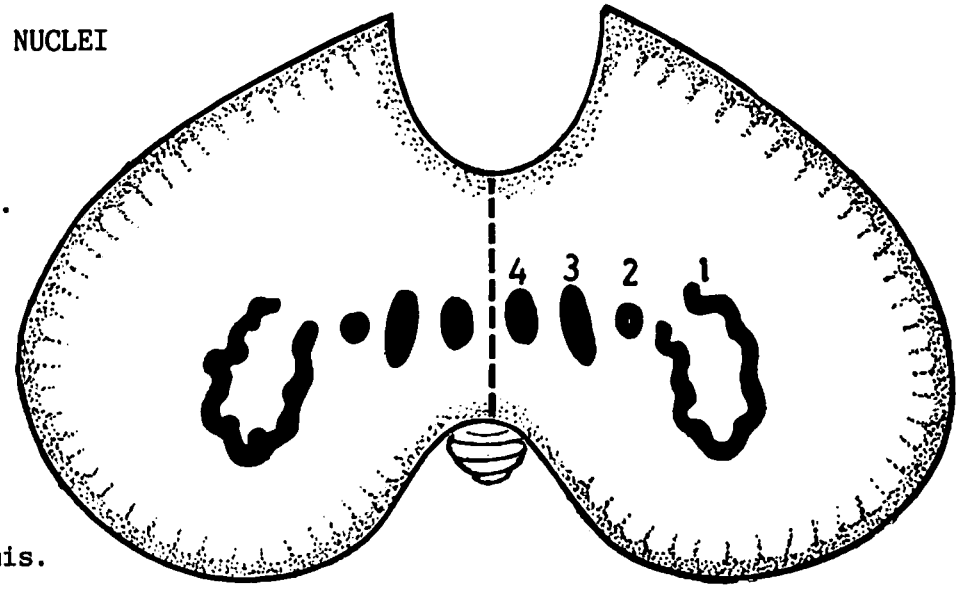


Fig.(176): CEREBELLAR NUCLEI

These are 4 nuclei embedded in the white matter of each cerebellar hemisphere. They are dentate nucleus, nucleus emboliformis, nucleus globosus and nucleus fastigii.

1. dentate nucleus (the largest and most lateral).
2. nucleus emboliformis.
3. nucleus globosus.
4. nucleus fastigii (most medial).



FOURTH VENTRICLE

Fig.(177): POSITION OF THE 4th VENTRICLE

The 4th ventricle is a tent-like space situated between the cerebellum behind and both the pons and upper 1/2 of the medulla in front.

1. midbrain.
2. pons.
3. medulla oblongata.
4. 4th ventricle.
5. cerebellum.

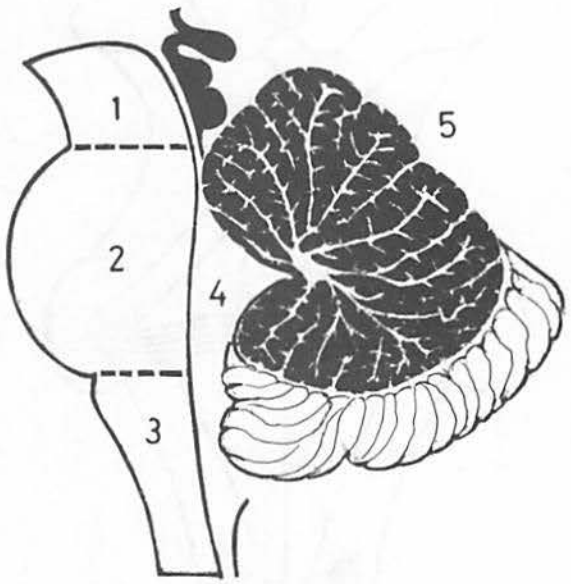
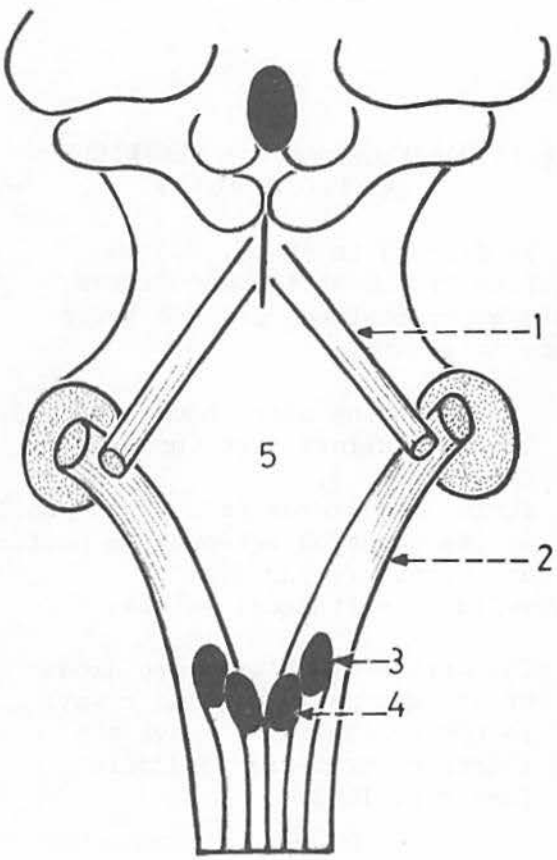


Fig.(178): BOUNDARIES OF THE 4th VENTRICLE

The 4th ventricle is bounded on each side above by the superior cerebellar peduncle, and below by the inferior cerebellar peduncle as well as by the gracile and cuneate tubercles.

1. superior cerebellar peduncle.
2. inferior cerebellar peduncle.
3. cuneate tubercle.
4. gracile tubercle.
5. 4th ventricle.



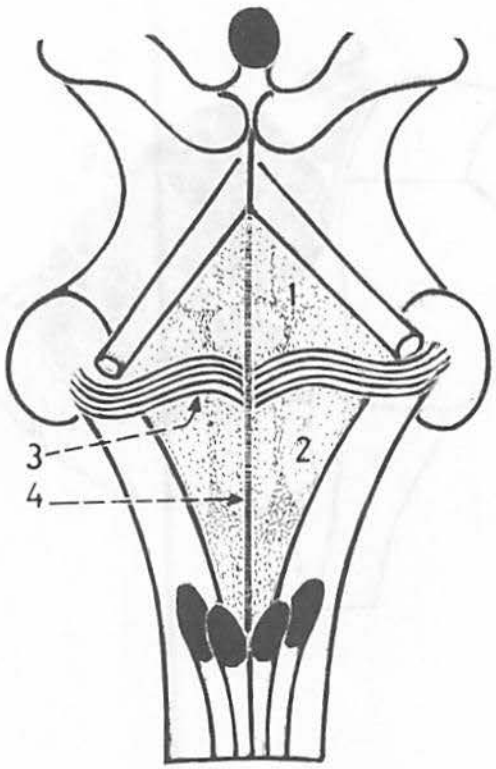


Fig.(179): FLOOR OF 4th VENTRICLE (RHOMBOID FOSSA)

It is diamond in shape, and is divided by the striae medullares into upper pontine part and lower medullary part.

1. upper pontine part (back of pons).
2. lower medullary part (back of open medulla).
3. striae medullares (run transversely at the junction between the pontine and medullary parts).
4. median longitudinal sulcus.

* The striae medullares are axons of arcuate nuclei on their way to the cerebellum through the inferior cerebellar peduncle (see fig. 169).

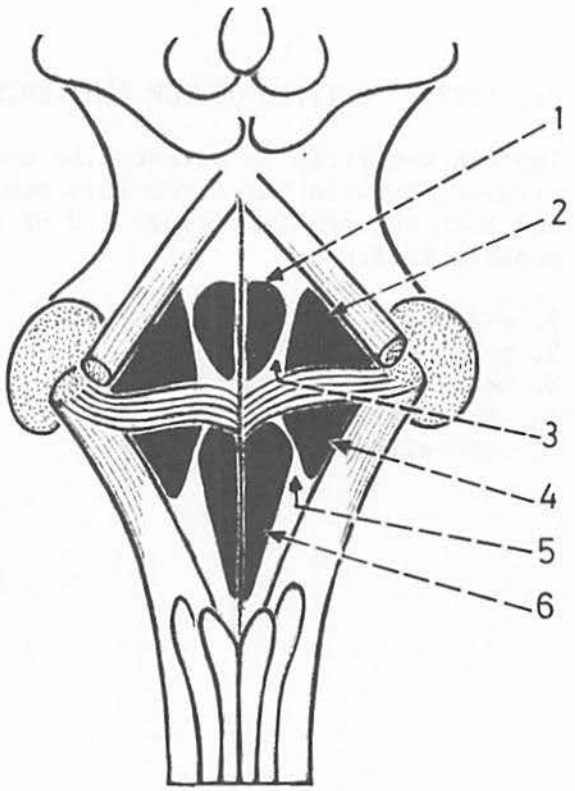


Fig.(180): ELEVATIONS IN THE FLOOR OF 4th VENTRICLE

There is a medial elevation along the median sulcus formed by the facial colliculus above and hypoglossal triangle below. There is also a lateral elevation called vestibular area formed by the vestibular nuclei.

1. facial colliculus.
2. upper part of vestibular area.
3. superior fovea (depression).
4. lower part of vestibular area.
5. inferior fovea (depression).
6. hypoglossal triangle (overlies the hypoglossal nucleus).

* The facial colliculus is formed by the abducent nucleus together with the surrounding fibres of facial nerve.

Fig.(181): ROOF OF 4th VENTRICLE

The upper part of the roof is formed by the superior medullary velum with the lingula placed over it, while the lower part is formed by the inferior medullary velum and ependyma which is perforated by the median aperture.

1. frenulum veli.
2. lingula (part of the anterior lobe of the cerebellum).
3. nodule of the flocculonodular lobe.
4. choroid plexus of arteries in the lower part of the roof.
5. median aperture of the ventricle (foramen of Magendie).
6. superior medullary velum.
7. flocculus.
8. inferior medullary velum.
9. ependyma in the lower part of the roof.

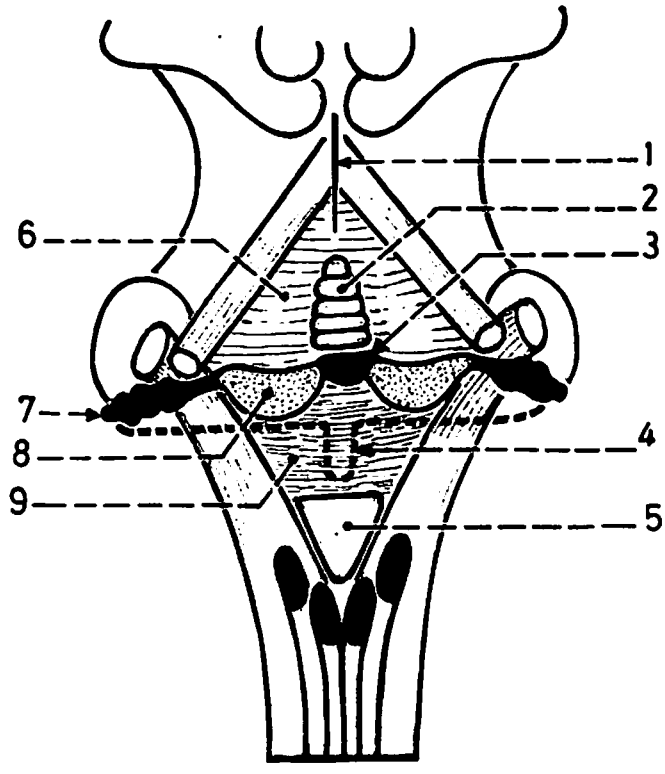


Fig.(182): EPENDYMAL LINING OF THE 4th VENTRICLE (sagittal section)

The ventricle is lined by ependyma which is continuous above with that lining the cerebral aqueduct and below with that lining the central canal of medulla oblongata. In the upper part of the roof, the ependyma lines the dorsal recess while in its lower part it is perforated by the median aperture.

1. cerebral aqueduct of midbrain.
2. cavity of 4th ventricle.
3. dorsal or cerebellar recess of the ventricle.
4. ependymal lining of the ventricle.
5. closed part of medulla.
6. central canal of the medulla.
7. median aperture in the roof of the ventricle.
8. lingula (overlies the superior medullary velum).

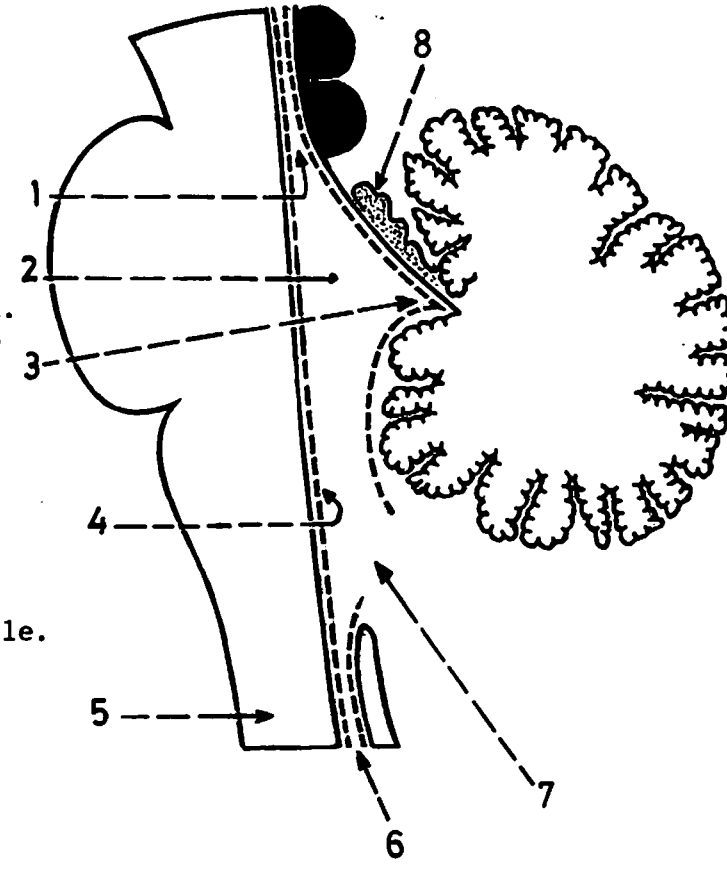


Fig.(183): LATERAL RECESSES OF 4th VENTRICLE

These are 2 tube-like lateral prolongations of the ependymal lining, one on each side. Each recess extends from the lateral angle of the ventricle to the cerebellopontine angle where it is perforated by the lateral aperture (foramen of Luschka).

1. superior cerebellar peduncle.
2. middle cerebellar peduncle.
3. lateral recess of 4th ventricle with its end perforated (foramen of Luschka).
4. inferior cerebellar peduncle.
5. median aperture in the ependyma of the lower part of the roof of the 4th ventricle (foramen of Magendie).

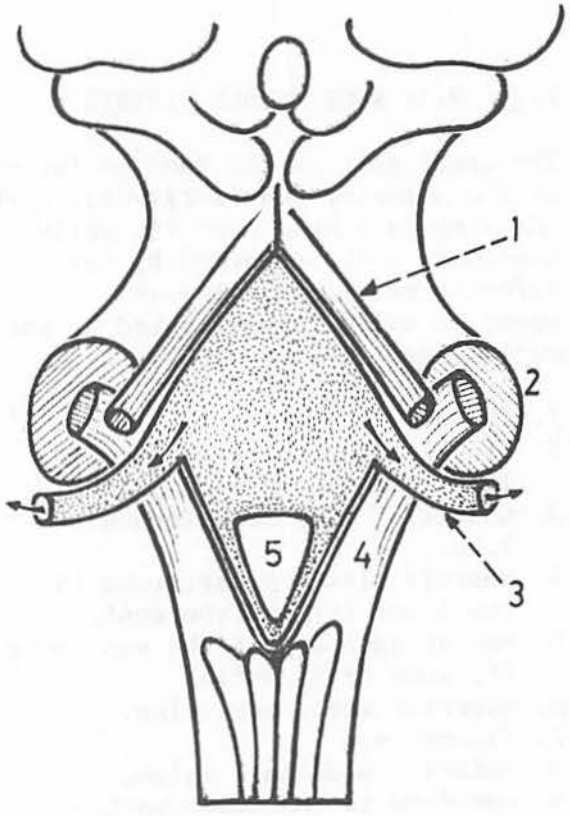


Fig.(184): RELATIONS OF THE LATERAL RECESS

It curves over the inferior cerebellar peduncle in contact with the flocculus of the cerebellum. Its lateral aperture lies at the cerebellopontine angle close to the emerging fibres of 7th, 8th, 9th and 10th cranial nerves.

1. flocculus of the cerebellum.
2. lateral recess of 4th ventricle.
3. inferior cerebellar peduncle.
4. 7th and 8th cranial nerves.
5. cerebellopontine angle.
6. rootlets of 9th and 10th cranial nerves.

* The cerebrospinal fluid leaves the 4th ventricle to enter the subarachnoid space through the median and the 2 lateral apertures of the ventricle.

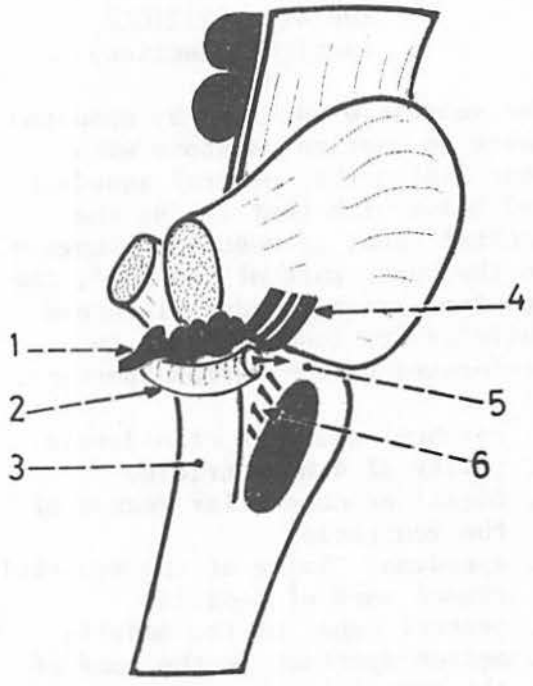


Fig.(185): CHOROID PLEXUSES OF 4th VENTRICLE

There are 2 arterial plexuses one on each side of the midline of the roof. Each plexus is L-shaped having a vertical limb and a horizontal limb.

1. flocculus of the cerebellum.
2. horizontal limb of the plexus (invaginates the lateral recess of the ventricle).
3. vertical limb of the plexus (invaginates the lower part of the ependyma of the roof).
4. median aperture of the ventricle.
5. inferior cerebellar peduncle.

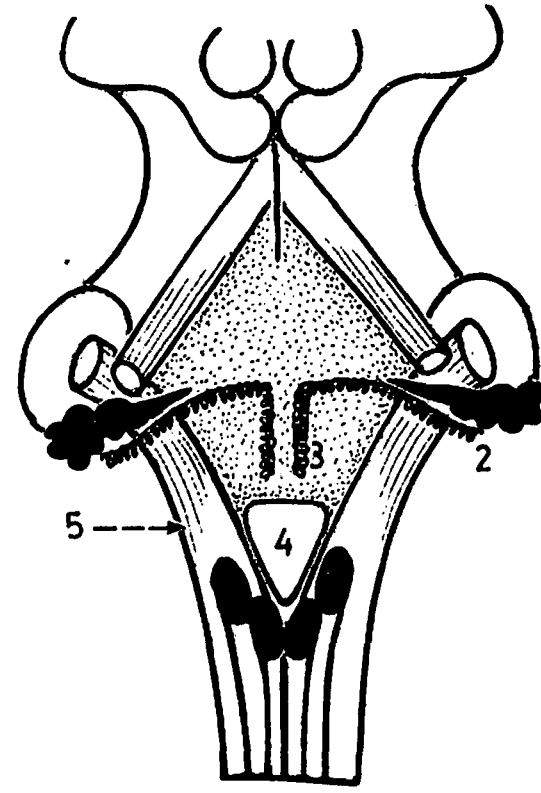
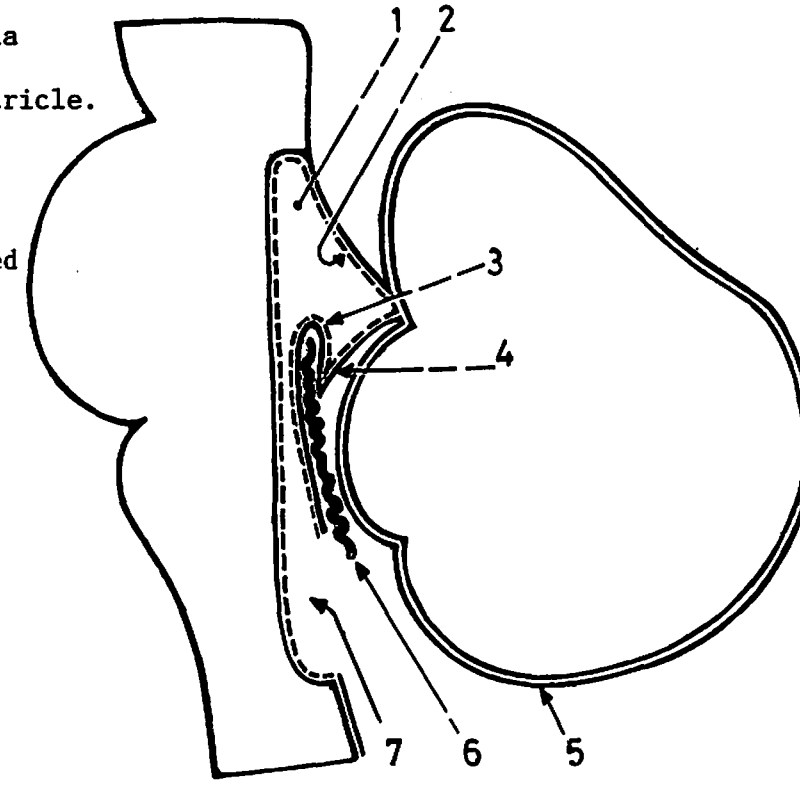


Fig.(186): TELA CHOROIDEA OF 4th VENTRICLE

Tela choroidea is a fold of pia mater which is invaginated by the choroid plexus of the ventricle.

1. cavity of 4th ventricle.
2. ependymal lining of the ventricle.
3. ependymal lining invaginated by the tela choroidea.
4. pia mater forming the tela choroidea.
5. pia mater covering the cerebellum.
6. choroid plexus of 4th ventricle.
7. median aperture of 4th ventricle.

* The choroid plexuses secrete cerebrospinal fluid into the cavity of the ventricle.



THALAMUS

GROSS MORPHOLOGY

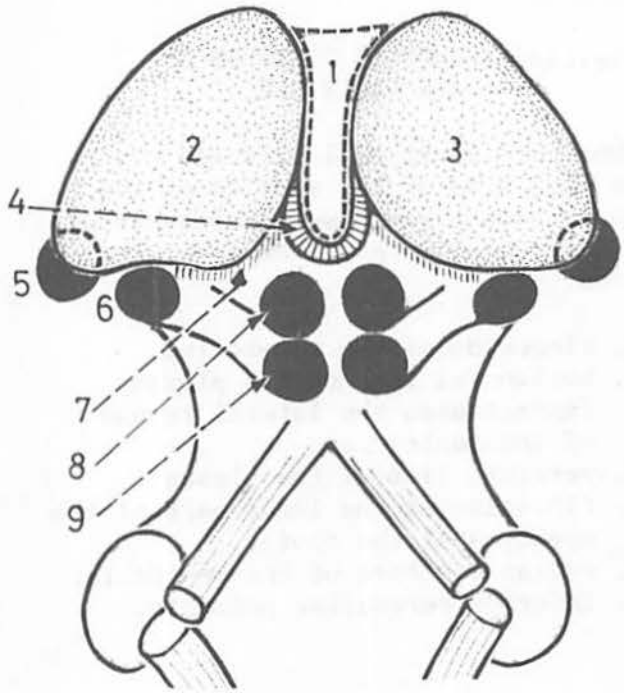


Fig.(187): PARTS OF THE DIENCEPHALON

The diencephalon consists of the thalamus, hypothalamus, metathalamus, subthalamus and epithalamus. The thalamus is the largest part of the diencephalon.

1. cavity of 3rd ventricle.
2. left thalamus.
3. right thalamus.
4. hypothalamus.
5. lateral geniculate body (part of the metathalamus).
6. medial geniculate body (part of the metathalamus).
7. subthalamus (below the thalamus, between it and the tegmentum of midbrain).
8. superior colliculus.
9. inferior colliculus.

* The diencephalon is the region between the brainstem and the base of the brain. Its cavity is the 3rd ventricle.

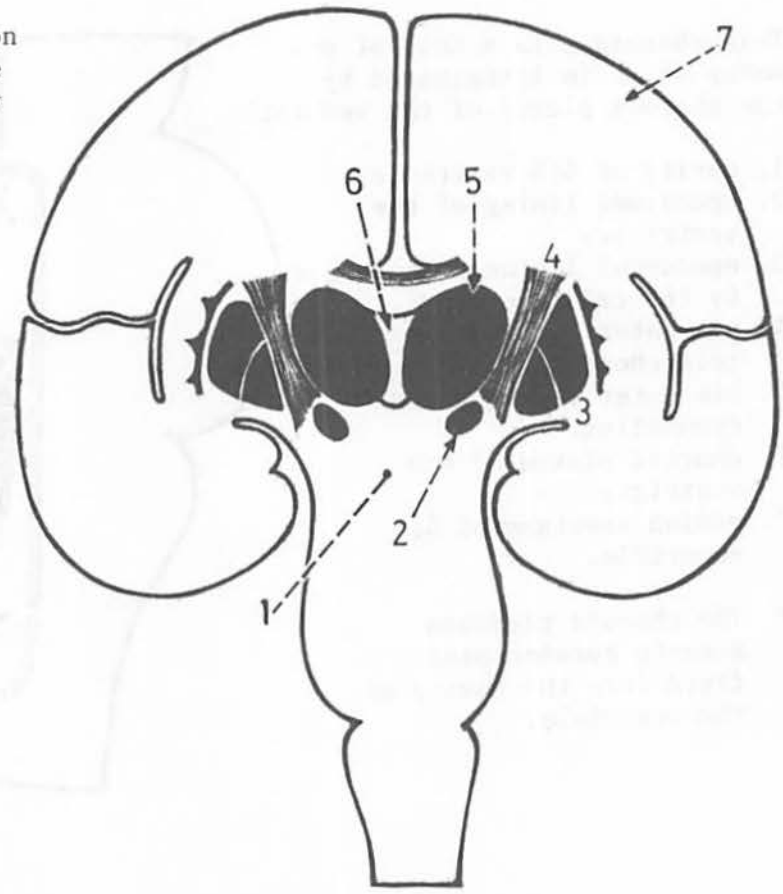


Fig.(188): POSITION OF THE THALAMUS (coronal section)

The thalamus is a large oval mass of grey matter which lies above the tegmentum of midbrain from which it is separated by the subthalamus. It is separated from its fellow of the opposite side by the 3rd ventricle.

1. tegmentum of midbrain.
2. subthalamic nucleus.
3. lentiform nucleus.
4. internal capsule.
5. thalamus.
6. 3rd ventricle.
7. cerebral hemisphere.

Fig.(189): MEDIAL SURFACE OF THE THALAMUS

It forms the lateral wall of the 3rd ventricle and is partly fused with the corresponding surface of the opposite thalamus by the interthalamic adhesion. Below, it is separated from the hypothalamus by the hypothalamic sulcus. Above, it shows an anteroposterior ridge of white matter called stria medullaris thalami.

1. fornix.
2. interthalamic adhesion.
3. interventricular foramen.
4. hypothalamus.
5. medial surface of the thalamus.
6. hypothalamic sulcus.
7. tegmentum of midbrain.
8. pineal body.
9. stria medullaris thalami.

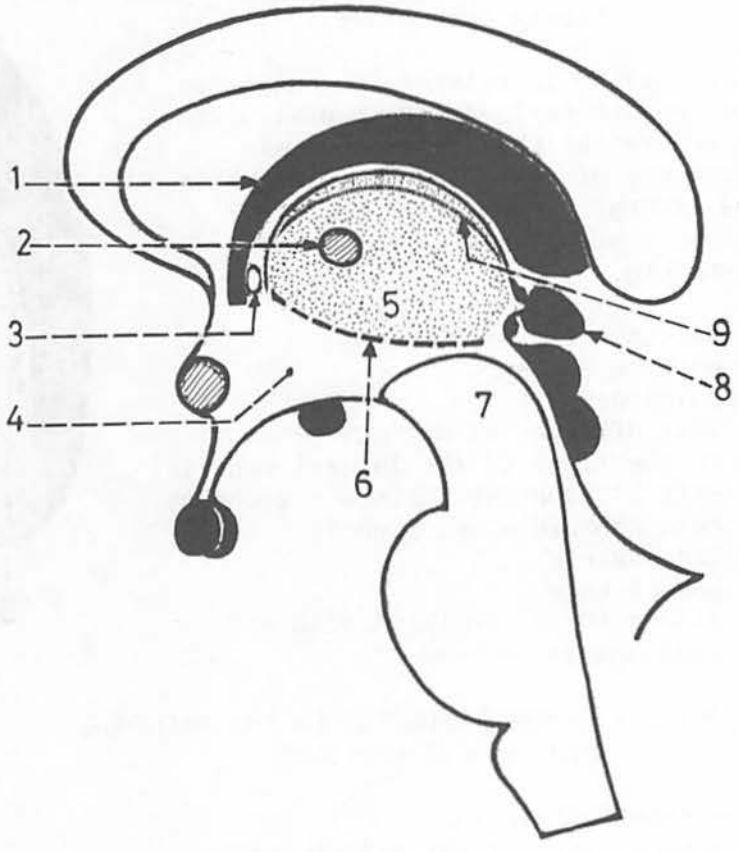


Fig.(190): SHAPE OF THE THALAMUS AS SEEN FROM ABOVE

The thalamus is oval in shape with its anterior end narrow and its posterior end broad and called the pulvinar.

1. interventricular foramen.
2. anterior end of thalamus.
3. superior surface of the thalamus.
4. lateral geniculate body.
5. pulvinar (overhangs the 2 geniculate bodies).
6. medial geniculate body.
7. posterior 1/3 of the medial surface (not covered by ependyma).
8. anterior 2/3 of medial surface (covered by ependyma).
9. pineal body.
10. 3rd ventricle.

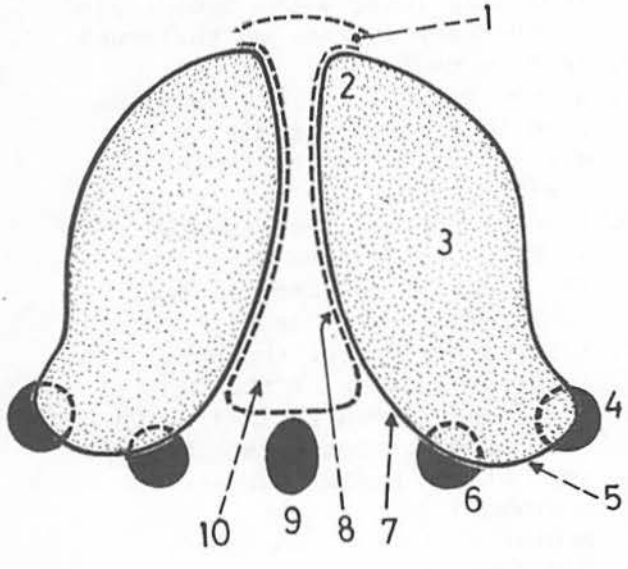
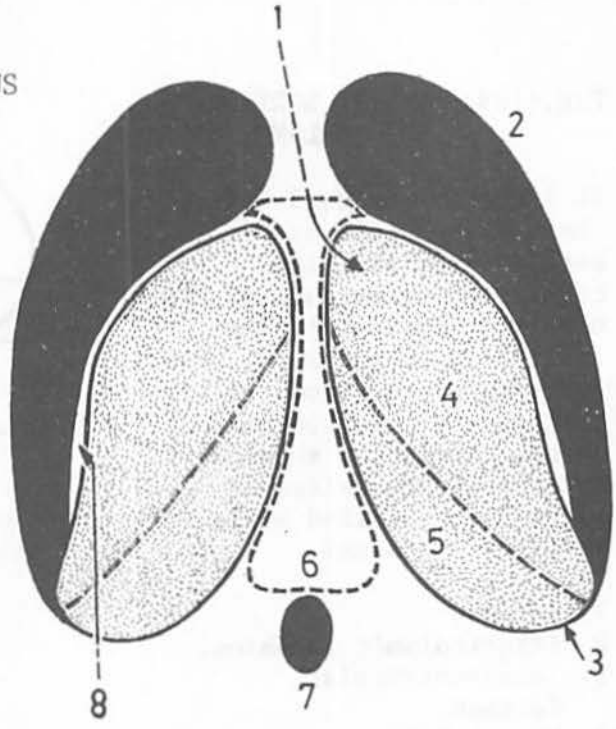


Fig.(191): SUPERIOR SURFACE OF THE THALAMUS
(seen from above)



This surface is related laterally to the caudate nucleus. Its medial part is covered by the fornix and tela choroidea of lateral ventricle, while its lateral part lies in the floor of the central part of the lateral ventricle.

1. anterior end of thalamus.
2. caudate nucleus.
3. pulvinar.
4. part of superior surface present in the floor of the lateral ventricle.
5. part of superior surface covered by tela choroidea and fornix.
6. 3rd ventricle.
7. pineal body.
8. groove for stria terminalis and thalamostriate vein.

Fig.(192): SUPERIOR SURFACE OF THE THALAMUS
(in coronal section)

1. corpus callosum.
2. central part of lateral ventricle.
3. fornix (covers the medial part of the superior surface of thalamus).
4. tela choroidea of lateral ventricle (covers the medial part of superior surface of thalamus).
5. caudate nucleus.
6. groove between the thalamus and caudate nucleus containing the stria terminalis and thalamostriate vein.
7. lateral part of the superior surface of thalamus (lies in the floor of the central part of lateral ventricle).
8. lateral surface of thalamus.
9. inferior surface of thalamus.
10. stria medullaris thalami (a thin band of white matter at the upper edge of the medial surface of thalamus).
11. medial surface of thalamus.
12. 3rd ventricle.

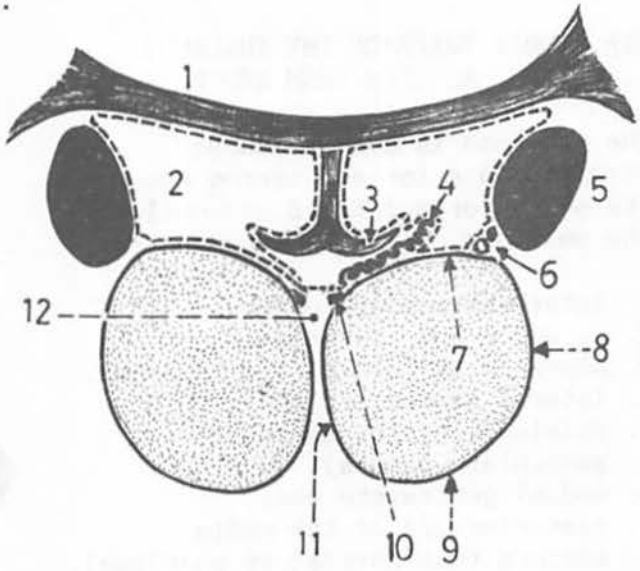
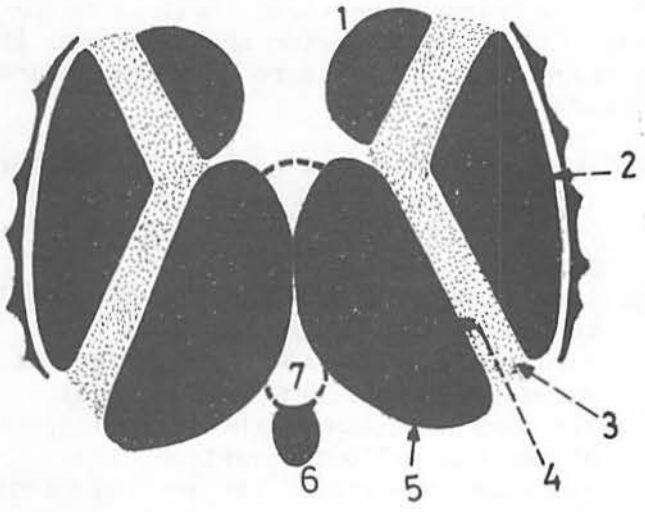


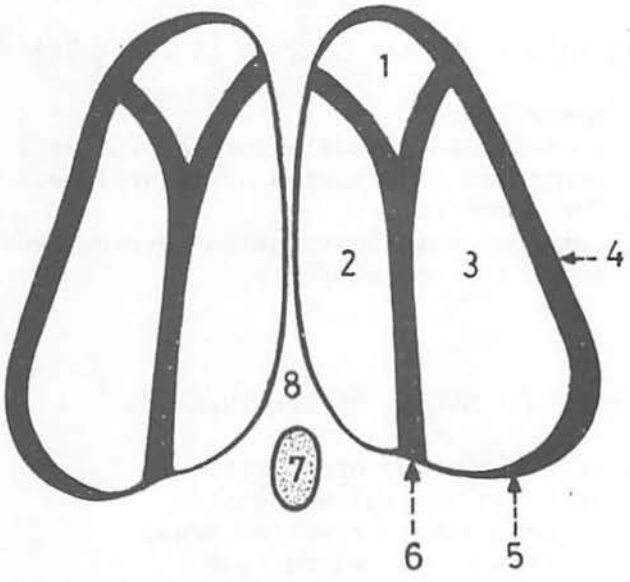
Fig.(193): LATERAL SURFACE OF THALAMUS
(horizontal section)



The lateral surface is related to the posterior limb of the internal capsule which separates the thalamus from the lentiform nucleus.

1. head of caudate nucleus.
2. lentiform nucleus.
3. posterior limb of internal capsule.
4. lateral surface of thalamus.
5. posterior part of medial surface of thalamus (does not share in the lateral wall of the 3rd ventricle).
6. pineal body.
7. 3rd ventricle.

Fig.(194): PARTS OF THE THALAMUS
(horizontal section)



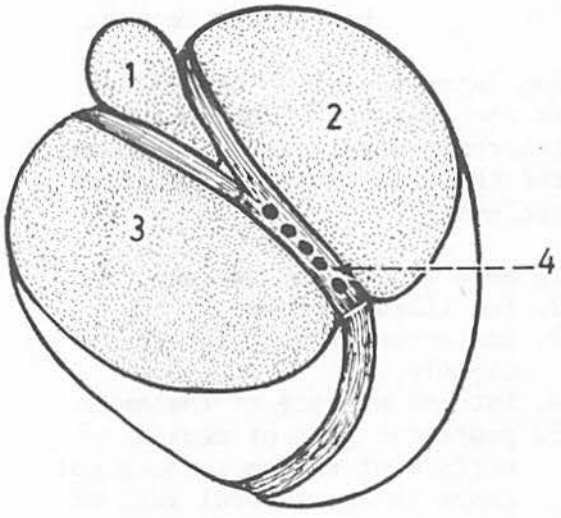
The thalamus is divided by a Y-shaped septum of white matter called internal medullary lamina into 3 main parts: anterior, medial and lateral. These parts consist of groups of nuclei each of which has a specific function.

1. anterior part.
2. medial part.
3. lateral part.
4. external medullary lamina (a layer of white matter covering the lateral surface of the thalamus).
5. pulvinar (posterior extension of the lateral part of thalamus).
6. internal medullary lamina (Y-shaped).
7. pineal body.
8. 3rd ventricle.

NUCLEI OF THE THALAMUS

Fig.(195): INTERNAL MEDULLARY LAMINA

It is a Y-shaped vertical sheet of white matter with its anterior end splitted. It divides the thalamus into 3 parts: anterior, medial and lateral.



1. anterior part: lies between the splitted anterior end of the medullary lamina. It consists of the anterior group of nuclei.
2. lateral part: lies lateral and ventral to the medullary lamina. It is subdivided into dorsolateral and ventromedial divisions. The dorsolateral division consists of the lateral group of nuclei, while the ventromedial division consists of the ventral group of nuclei.
3. medial part: lies medial to the medullary lamina, and consists of the medial group of nuclei.
4. internal medullary lamina: a Y-shaped vertical sheet of white matter which curves medially. It lodges the intralaminar group of nuclei.

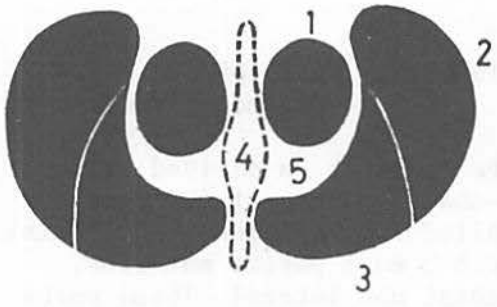
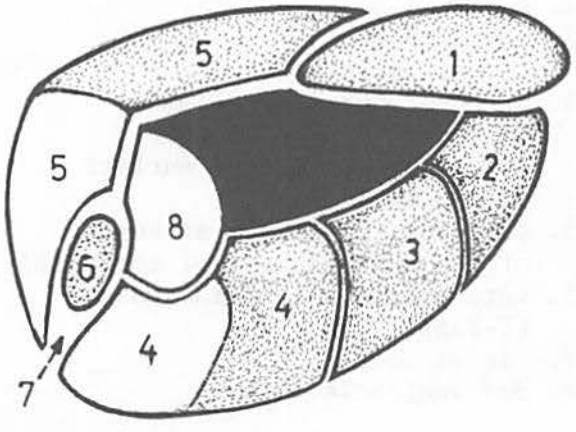


Fig.(196): CORONAL SECTION IN THE 2 THALAMI

1. medial part.
2. dorsolateral division of lateral part.
3. ventromedial division of lateral part.
4. 3rd ventricle.
5. internal medullary lamina (curves medially below the medial part).

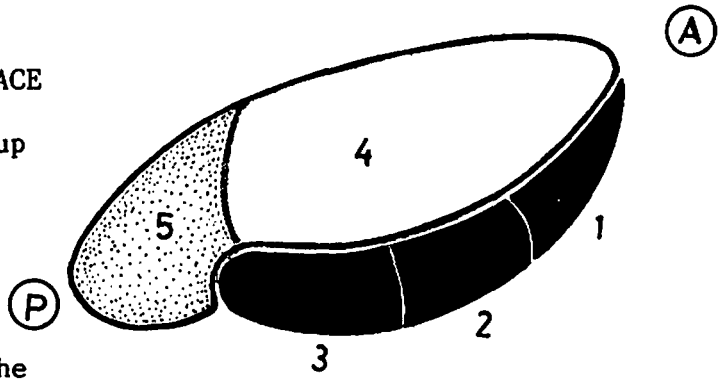
Fig.(197): NUCLEI OF THE THALAMUS



1. anterior group of nuclei.
2. anterior ventral nucleus.
3. intermediate ventral nucleus.
4. posterior ventral nucleus.
5. medial group of nuclei.
6. centromedian nucleus (the largest of the intralaminar nuclei).
7. internal medullary lamina.
8. lateral group of nuclei.

* The ventral group of nuclei consist of the anterior ventral, intermediate ventral and posterior ventral nuclei.

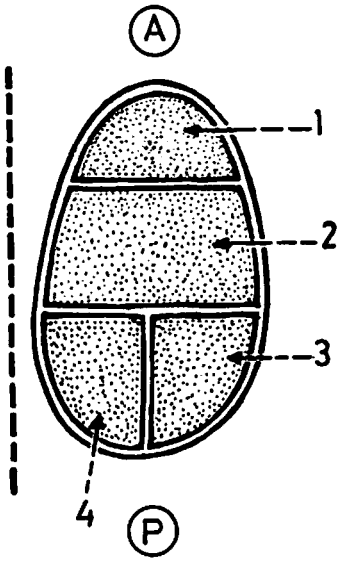
Fig.(198): NUCLEI OF THE THALAMUS
SEEN FROM THE LATERAL SURFACE



These are the lateral and ventral group of nuclei as well as the pulvinar.

1. anterior ventral nucleus.
2. intermediate ventral nucleus.
3. posterior ventral nucleus.
4. lateral group of nuclei.
5. pulvinar (posterior extension of the lateral part of the thalamus).

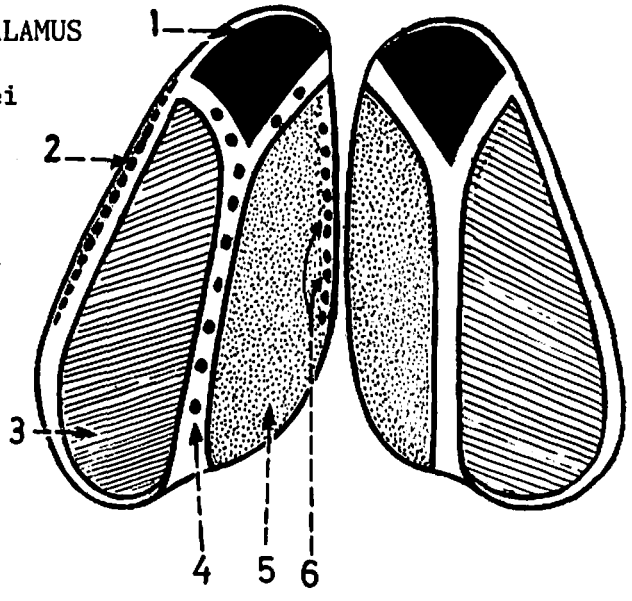
Fig.(199): VENTRAL GROUP OF NUCLEI



These are the anterior ventral, intermediate ventral and posterior ventral. The posterior ventral nucleus is subdivided into posterolateral ventral and posteromedial ventral nuclei.

1. anterior ventral nucleus.
2. intermediate ventral nucleus.
3. posterolateral ventral nucleus.
4. posteromedial ventral nucleus.

Fig.(200): NON-SPECIFIC NUCLEI OF THE THALAMUS



These are the intralaminar nuclei, nuclei of the midline and reticular nucleus of the thalamus.

1. anterior nucleus of thalamus.
2. reticular nucleus (lies on the lateral surface of the thalamus).
3. lateral group of nuclei.
4. intralaminar group of nuclei (in the internal medullary lamina).
5. medial group of nuclei.
6. nuclei of the midline (on the medial surface of the thalamus).

CONNECTIONS OF THE THALAMUS

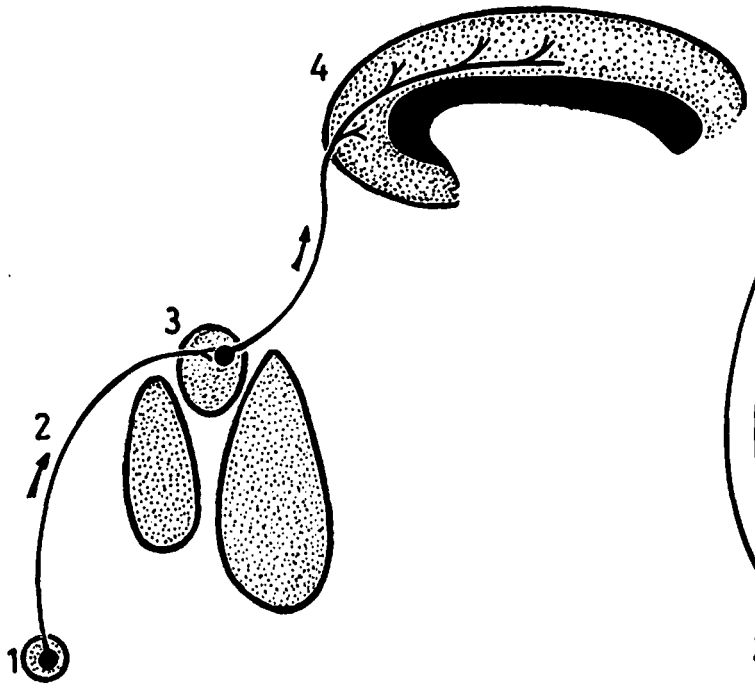


Fig.(201): CONNECTIONS OF ANTERIOR GROUP OF NUCLEI

They receive afferents from the mamillary body and send efferents to the cingulate gyrus.

1. mamillary body.
2. mamillothalamic tract.
3. anterior nuclei of thalamus.
4. cingulate gyrus.

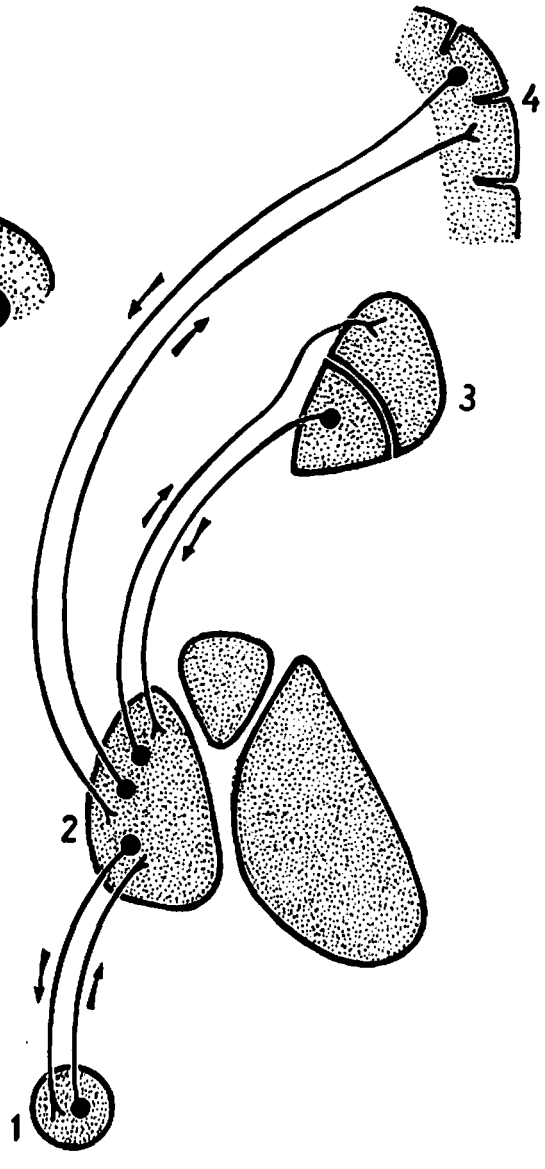


Fig.(202): CONNECTIONS OF MEDIAL GROUP OF NUCLEI

These nuclei receive afferents and give efferents to the frontal lobe, corpus striatum and hypothalamus.

1. hypothalamus.
2. medial group of nuclei of thalamus.
3. lentiform nucleus.
4. prefrontal cortex of the frontal lobe.

Fig.(203):CONNECTIONS OF LATERAL GROUP OF NUCLEI AND PULVINAR

The lateral nuclei are interconnected with the other thalamic nuclei. The pulvinar is connected with the temporal, occipital and parietal lobes.

1. anterior nuclei of thalamus.
2. medial nuclei of thalamus.
3. pulvinar.
4. lateral nuclei of thalamus.
5. temporal lobe.
6. occipital lobe.
7. Wernicke's speech area in the parietal lobe.

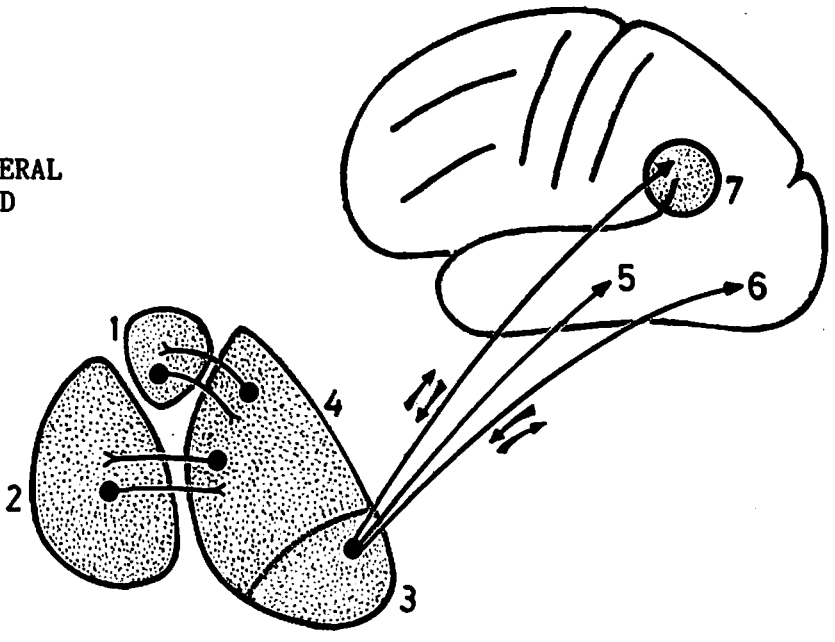
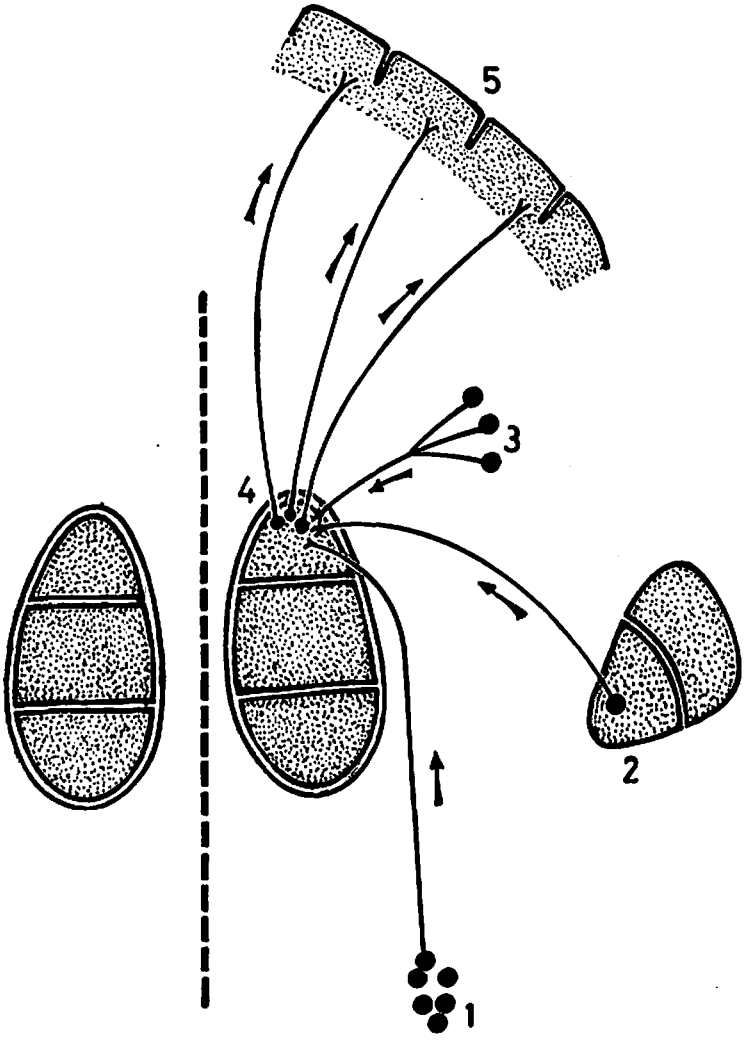


Fig.(204): CONNECTIONS OF ANTERIOR VENTRAL NUCLEUS

It receives afferents from the globus pallidus, reticular formation and non-specific nuclei of thalamus. It sends efferents to the motor and premotor areas of the frontal cortex.

1. reticular formation of brainstem.
2. lentiform nucleus (part of corpus striatum).
3. non-specific nuclei of thalamus.
4. anterior ventral nucleus of thalamus.
5. motor and premotor areas of the frontal cortex.



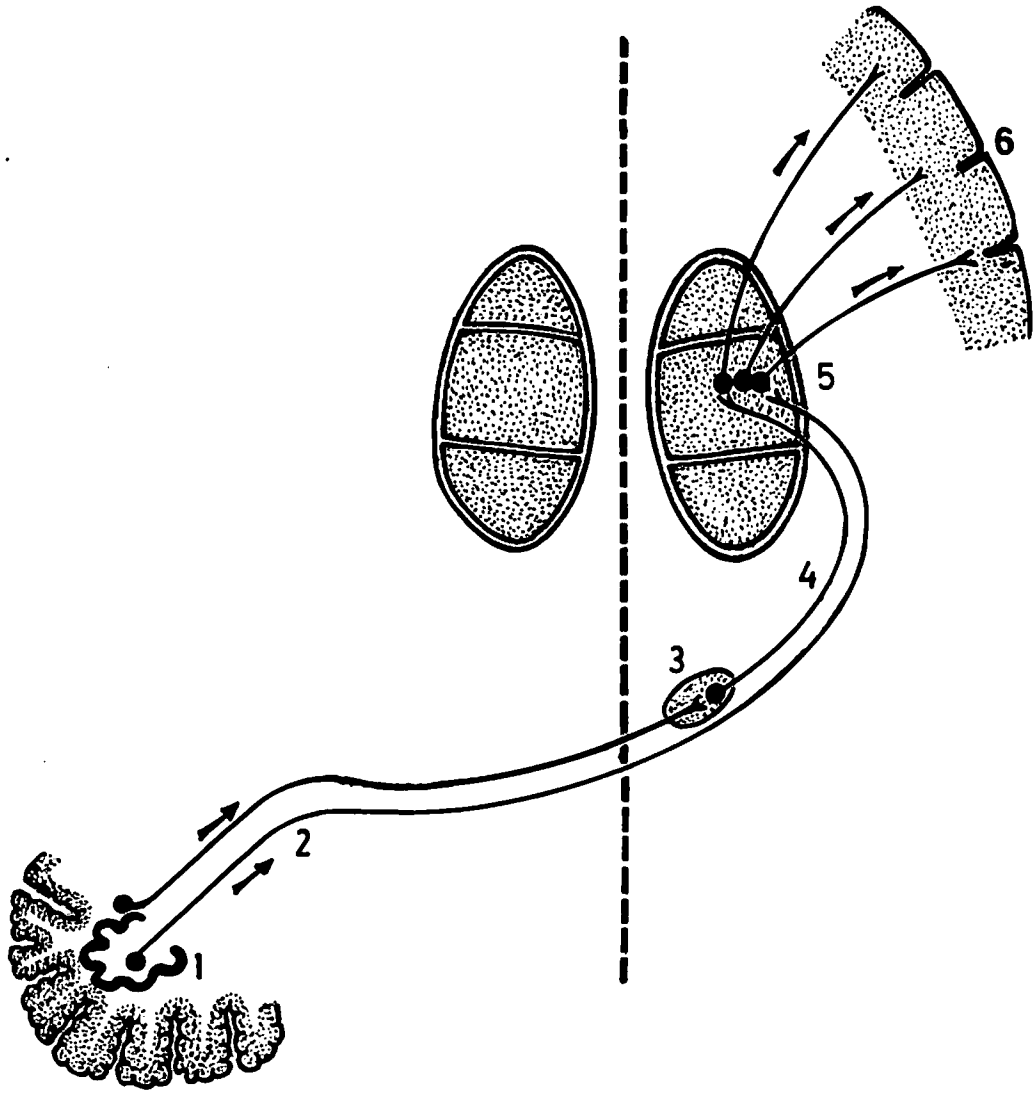


Fig.(205): CONNECTIONS OF INTERMEDIATE VENTRAL (LATERAL VENTRAL) NUCLEUS

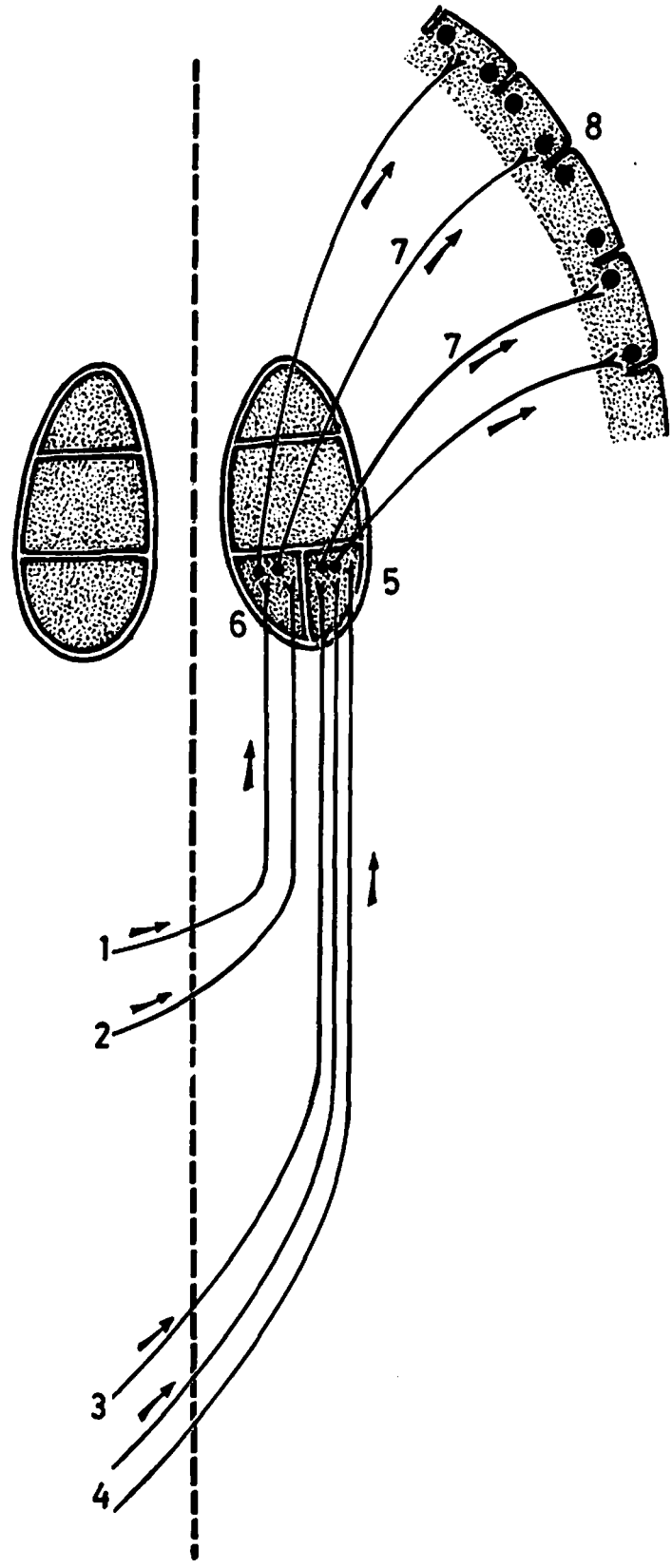
It receives afferents from the contralateral cerebellar hemisphere via the dentato-thalamic and dentato-rubro-thalamic pathways. It sends efferents to the motor and premotor areas of the frontal cortex.

1. dentate nucleus.
2. dentato-thalamic fibres.
3. red nucleus.
4. rubrothalamic fibres.
5. intermediate ventral nucleus of thalamus.
6. motor and premotor areas of the frontal cortex.

Fig.(206): CONNECTIONS OF POSTERIOR VENTRAL NUCLEUS

It receives afferents from the medial lemniscus, spinal lemniscus and trigeminal lemniscus in addition to taste fibres. It sends efferents to th postcentral gyrus (areas 3, 1, 2).

1. taste fibres (from the solitary nucleus).
2. trigeminal lemniscus (from the head).
3. medial lemniscus (from the body below the head).
4. spinal lemniscus (combined lateral and anterior spino-thalamic tracts).
5. posterolateral ventral nucleus (receives the medial and spinal lemnisci).
6. posteromedial ventral nucleus (receives the trigeminal lemniscus and taste fibres).
7. thalamo-cortical fibres forming the superior thalamic radiation.
8. postcentral gyrus of the parietal lobe.



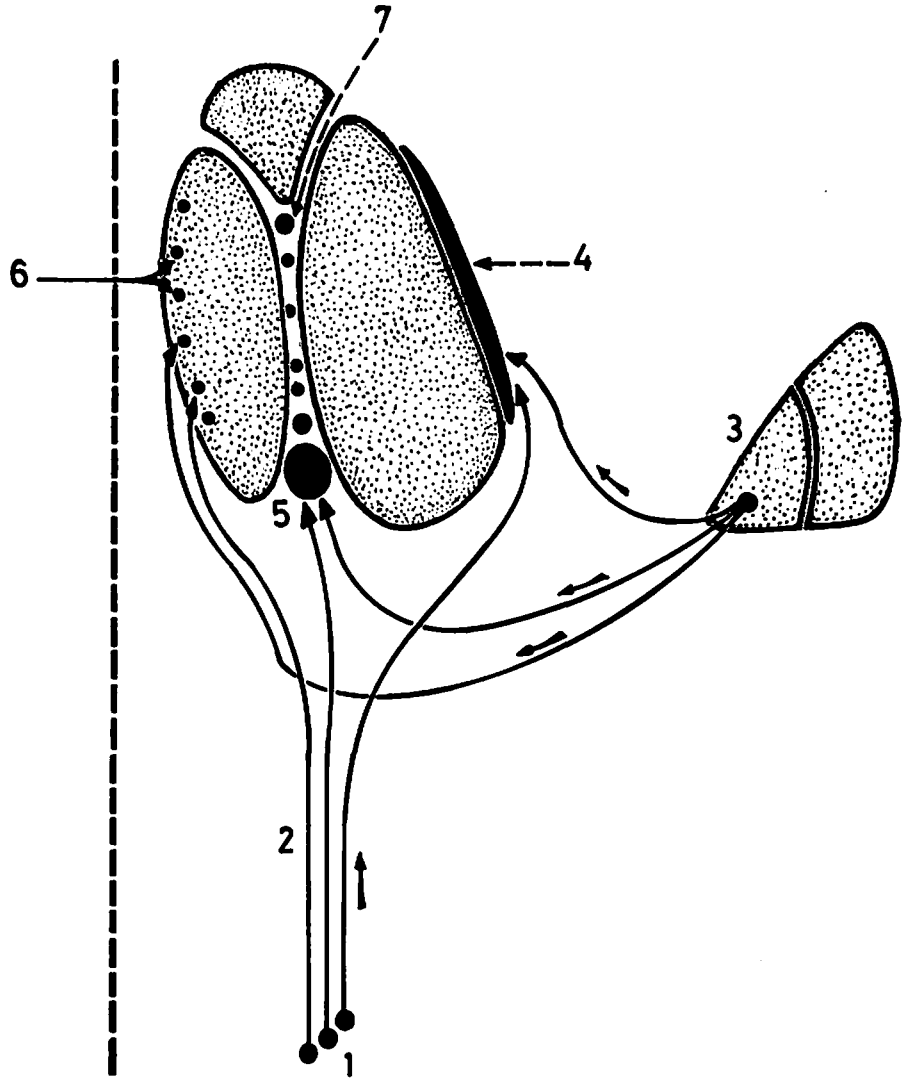


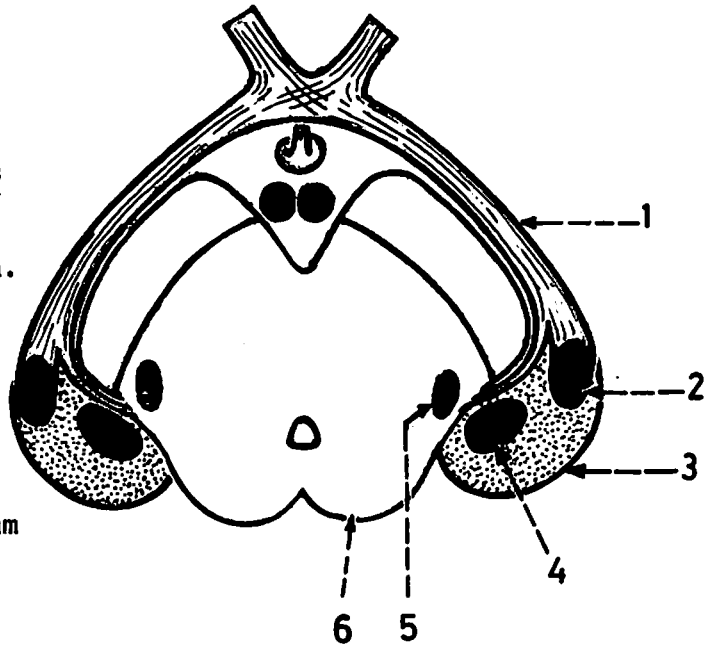
Fig.(207): CONNECTIONS OF NON-SPECIFIC NUCLEI OF THALAMUS

These nuclei represent the upward continuation of the reticular formation of the brainstem. They receive reticulothalamic fibres from the reticular nuclei of the brainstem, in addition to afferent fibres from the corpus striatum. They send efferent fibres to the cerebral cortex of both sides.
These nuclei are: intralaminar nuclei (including the centromedian nucleus), reticular nucleus and nuclei of the midline.

1. reticular nuclei of brainstem.
2. reticulo-thalamic fibres.
3. lentiform nucleus.
4. reticular nucleus of thalamus.
5. centromedian nucleus.
6. nuclei of the midline of thalamus.
7. intralaminar nuclei of thalamus.

METATHALAMUS

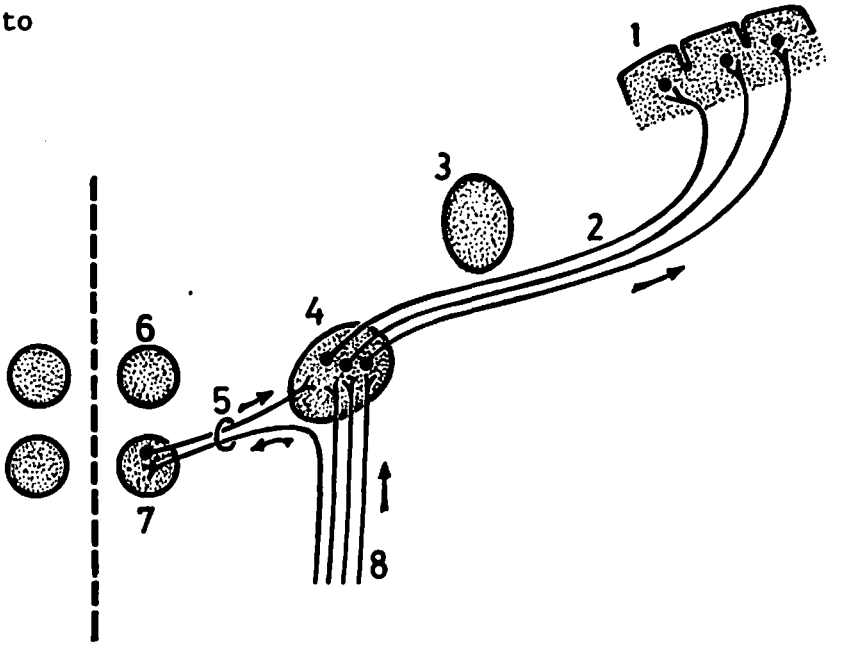
Fig.(208): POSITION OF THE GENICULATE BODIES



The metathalamus consists of the lateral and medial geniculate bodies which lie on the inferior surface of the pulvinar, 2 on each side of the upper part of the tectum of midbrain.

1. optic tract (most of its fibres end in the lateral geniculate body).
2. lateral geniculate body.
3. pulvinar of the thalamus.
4. medial geniculate body.
5. lateral lemniscus in the tegmentum of midbrain.
6. superior colliculus.

Fig.(209): CONNECTIONS OF MEDIAL GENICULATE BODY



It receives afferents from the lateral lemniscus (majority) and from the inferior colliculus (few). It sends efferents in the form of auditory radiation to the auditory centre in the temporal lobe.

1. auditory centre in the temporal lobe.
2. auditory radiation.
3. lateral geniculate body.
4. medial geniculate body.
5. brachiun of inferior colliculus.
6. superior colliculus.
7. inferior colliculus.
8. lateral lemniscus (auditory fibres).

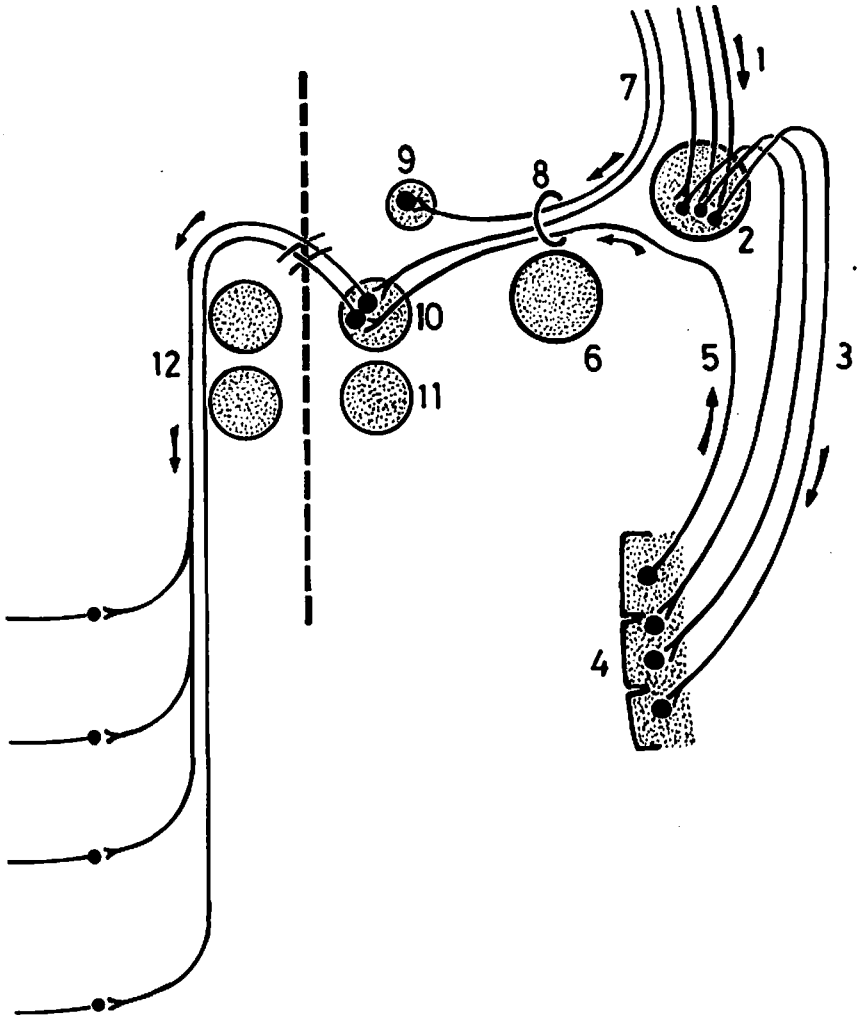


Fig.(210): CONNECTIONS OF LATERAL GENICULATE BODY

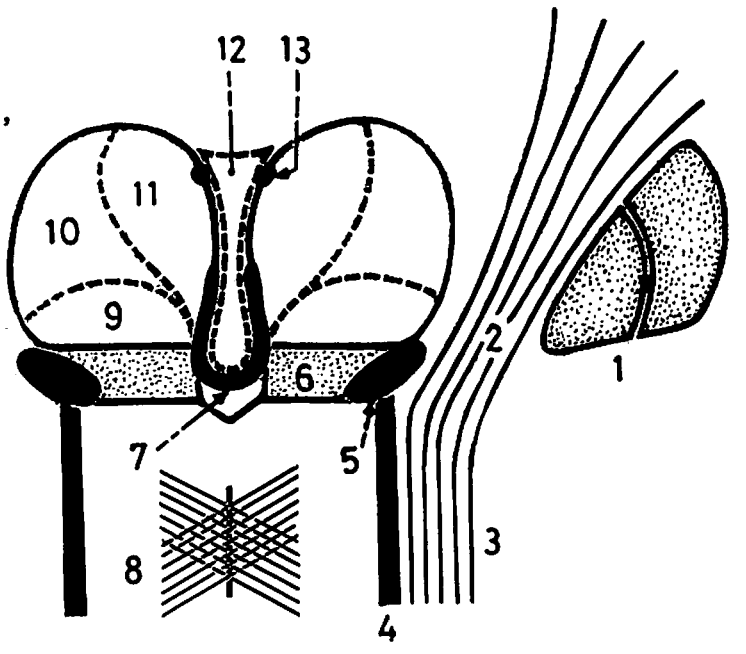
It receives afferents from the optic tract, and sends its efferents in the form of optic radiation to the visual centre in the occipital lobe.

1. optic tract.
2. lateral geniculate body.
3. optic radiation.
4. visual centre in the occipital cortex.
5. efferent fibres from the occipital cortex to the superior colliculus passing through the brachium of superior colliculus.
6. medial geniculate body.
7. fibres from the optic tract passing in the brachium of superior colliculus to the pretectal nucleus and superior colliculus.
8. brachium of superior colliculus.
9. pretectal nucleus.
10. superior colliculus.
11. inferior colliculus.
12. tectospinal tract.

SUBTHALAMUS

Fig.(211): POSITION OF SUBTHALAMUS

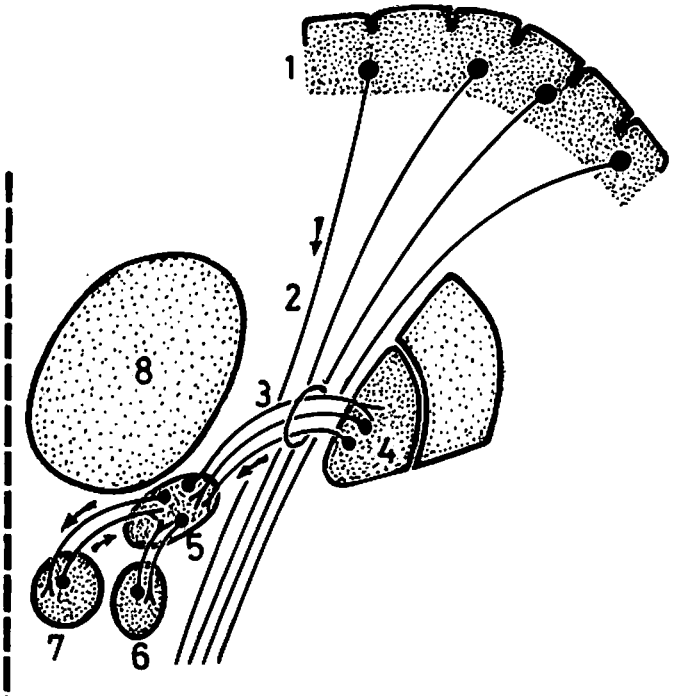
It is the part of the diencephalon which lies below the thalamus, intervening between it and the tegmentum of midbrain. Medially it is related to the hypothalamus, and laterally it is related to the internal capsule. It contains a large nucleus called the subthalamic nucleus.



1. lentiform nucleus.
2. internal capsule.
3. crus cerebri.
4. substantia nigra.
5. subthalamic nucleus.
6. subthalamus.
7. horizontal part of hypothalamus.
8. decussation of superior peduncles in the midbrain.
9. ventral group of nuclei of thalamus.
10. lateral group of nuclei of thalamus.
11. medial group of nuclei of thalamus.
12. 3rd ventricle.
13. stria medullaris thalami.

Fig.(212): CONNECTIONS OF SUBTHALAMIC NUCLEUS

It is connected by afferent and efferent fibres to the globus pallidus, red nucleus and substantia nigra.



1. cerebral cortex.
2. internal capsule.
3. subthalamic fasciculus.
4. globus pallidus.
5. subthalamic nucleus.
6. substantia nigra.
7. red nucleus.
8. thalamus.

* The subthalamic nucleus is an extrapyramidal centre.

EPITHALAMUS

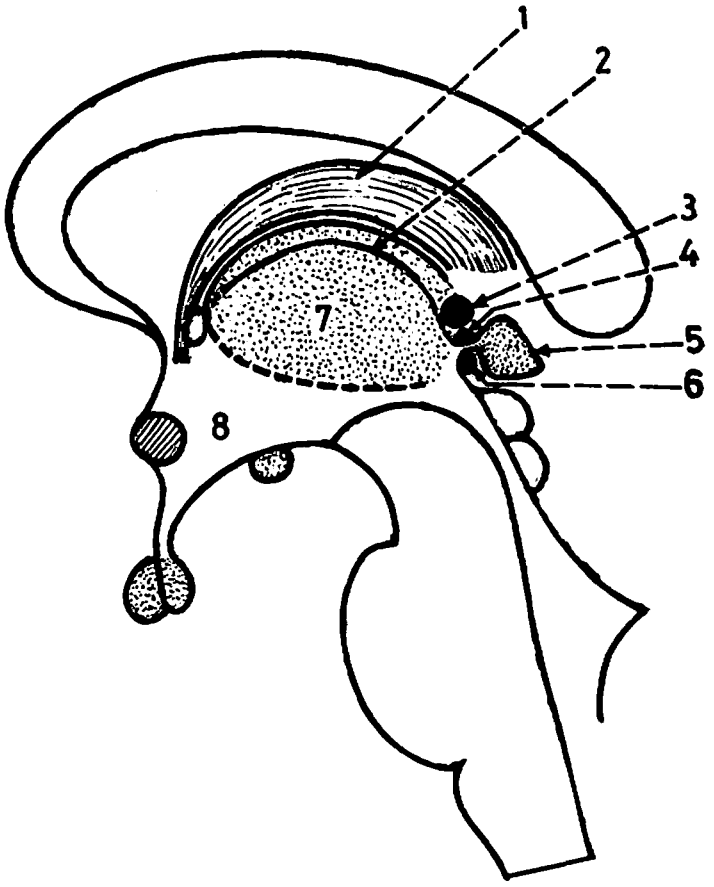


Fig.(213): POSITION AND PARTS OF EPITHALAMUS

The epithalamus lies on the upper part of the medial surface of the thalamus. It consists of stria medullaris thalami, habenular nucleus, pineal body, habenular commissure and posterior commissure.

1. fornix.
2. stria medullaris thalami (a band of white fibres which passes backwards on the upper part of the medial surface of the thalamus to end in the habenular nucleus).
3. habenular nucleus (lies in the habenular trigone just cranial to the superior colliculus).
4. habenular commissure (in the cranial lamina of the pineal stalk).
5. pineal body.
6. posterior commissure (in the caudal lamina of the pineal stalk).
7. thalamus.
8. hypothalamus.

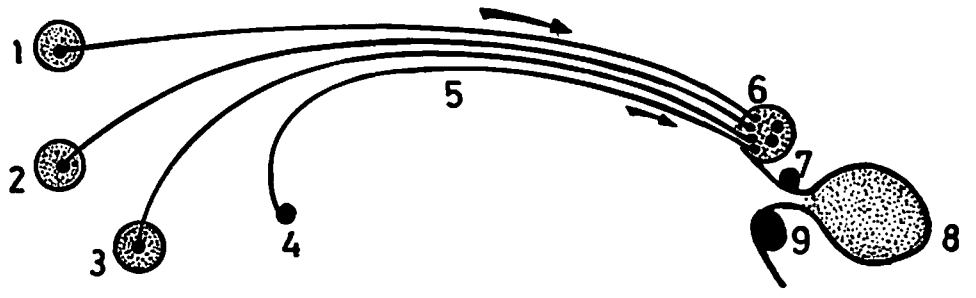


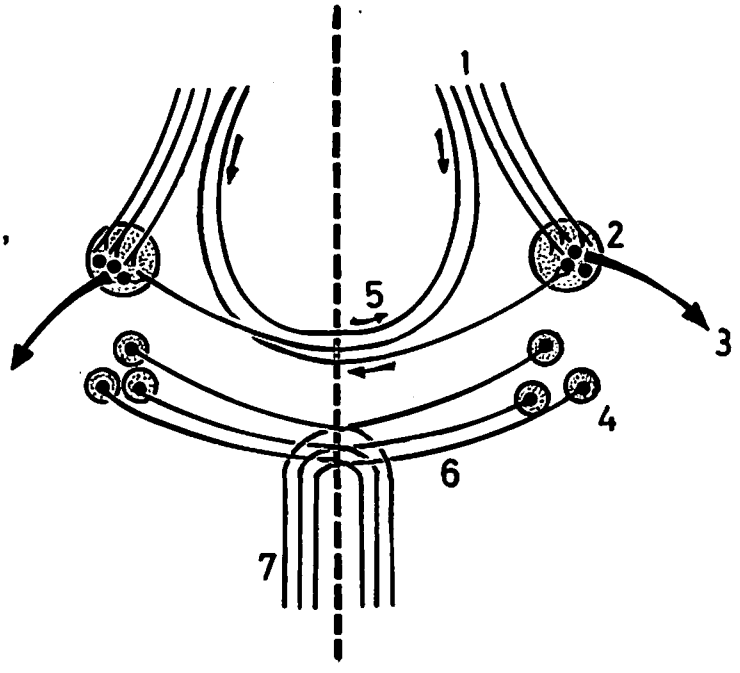
Fig.(214): STRIA MEDULLARIS THALAMI

It consists of a group of fibres which arise from the olfactory tubercle, hippocampus, amygdaloid body and preoptic nucleus of the hypothalamus. Its fibres end in the habenular nucleus.

1. olfactory tubercle.
2. hippocampus.
3. amygdaloid body.
4. preoptic nucleus.
5. stria medullaris thalami.
6. habenular nucleus.
7. habenular commissure.
8. pineal body.
9. posterior commissure.

Fig.(215): HABENULAR AND POSTERIOR COMMISSURES

The habenular commissure connects the habenular nuclei of both sides together. It crosses in the cranial lamina of the pineal stalk. The posterior commissure connects the nucleus of posterior commissure, interstitial nucleus of Cajal and nucleus of Darkschewitsch of both sides together. It crosses in the caudal lamina of the pineal stalk, and gives fibres to the medial longitudinal bundles of both sides.



1. stria medullaris thalami.
2. habenular nucleus.
3. efferent fibres from the habenular nucleus to the reticular formation of midbrain.
4. nuclei of posterior commissure.
5. habenular commissure.
6. posterior commissure.
7. medial longitudinal bundle.

HYPOTHALAMUS

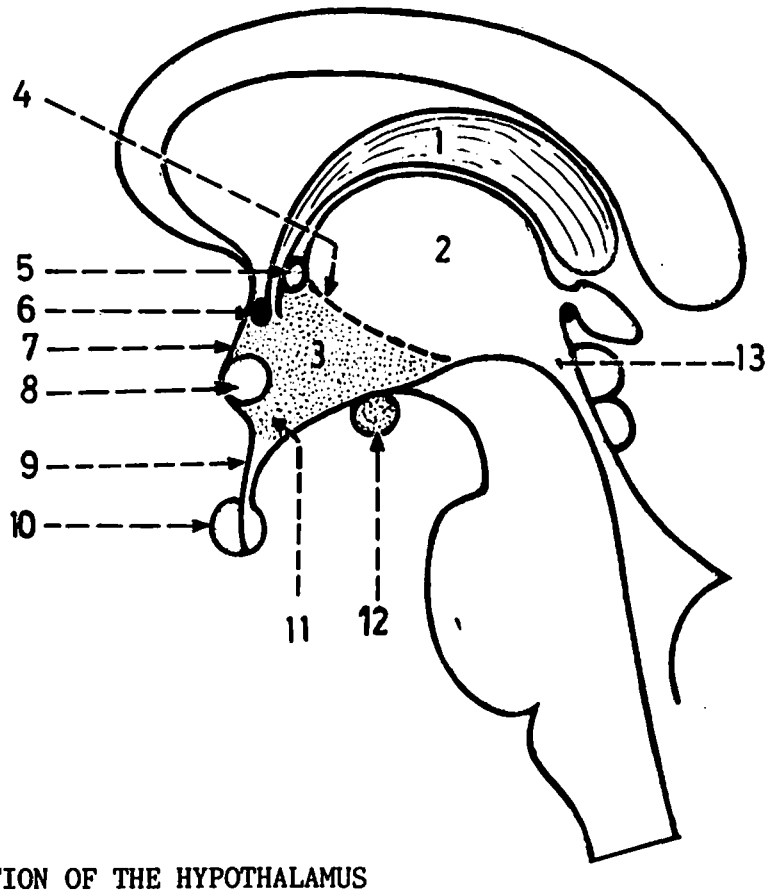
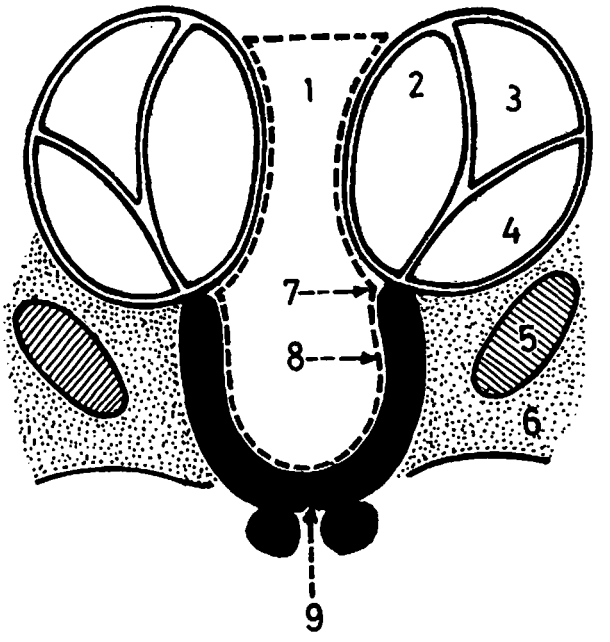


Fig.(216): POSITION OF THE HYPOTHALAMUS
(sagittal section)

The hypothalamus is a part of the diencephalon which has a vertical part and a horizontal part. The vertical part forms the lower part of the lateral wall of the 3rd ventricle and is separated from the thalamus by the hypothalamic sulcus. The horizontal part forms the floor of the 3rd ventricle, and consists of the tuber cinereum and the 2 mamillary bodies.
The hypothalamus is limited anteriorly by the optic chiasma, lamina terminalis and anterior commissure, and ends posteriorly just behind the mamillary bodies.

1. fornix.
2. thalamus (forms the upper part of lateral wall of 3rd ventricle).
3. vertical part of hypothalamus (forms the lower part of lateral wall of 3rd ventricle).
4. hypothalamic sulcus (intervenes between the thalamus and hypothalamus, and extends from the interventricular foramen in front to the cerebral aqueduct behind).
5. interventricular foramen (just in front of the thalamus).
6. anterior commissure.
7. lamina terminalis.
8. optic chiasma.
9. infundibulum (connects the tuber cinereum with the posterior lobe of pituitary gland).
10. pituitary gland (hypophysis cerebri).
11. tuber cinereum.
12. mamillary body.
13. cerebral aqueduct.

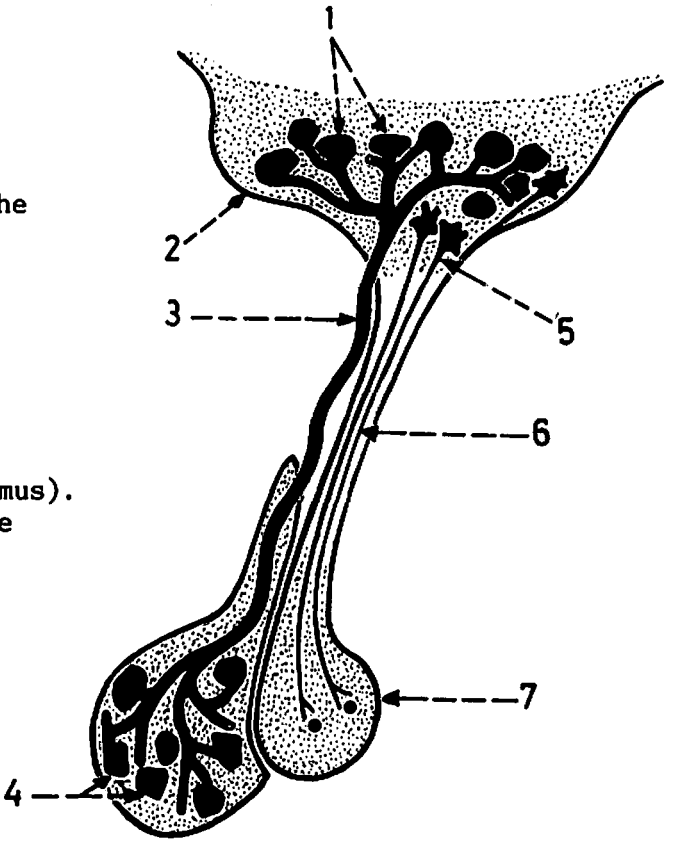
Fig.(217): HORIZONTAL AND VERTICAL PARTS OF HYPOTHALAMUS (coronal section)



The horizontal part of hypothalamus forms the floor of the 3rd ventricle, while the vertical part forms the lower part of the lateral wall of the ventricle, and is related laterally to the subthalamus.

1. 3rd ventricle.
2. medial nuclei of thalamus.
3. lateral nuclei of thalamus.
4. ventral nuclei of thalamus.
5. subthalamic nucleus.
6. subthalamus (below the thalamus and lateral to the hypothalamus).
7. hypothalamic sulcus.
8. vertical part of hypothalamus.
9. horizontal part of hypothalamus forming the floor of 3rd ventricle.

Fig.(218): CONNECTIONS BETWEEN HYPOTHALAMUS AND PITUITARY GLAND



The hypothalamus is connected with the posterior lobe of pituitary by nerve fibres, but is connected with the anterior lobe of pituitary by blood vessels (hypothalamo-hypophyseal portal vessels).

1. blood sinusoids in the tuber cinereum.
2. tuber cinereum (part of hypothalamus).
3. portal vessel to the anterior lobe of pituitary.
4. sinusoids in the anterior lobe of pituitary.
5. nerve cells of the supra-optic, paraventricular and infundibular nuclei of hypothalamus.
6. nerve fibres passing in the infundibulum to the posterior lobe of pituitary.
7. posterior lobe of pituitary (neurohypophysis).

Fig.(219): NUCLEI OF HYPOTHALAMUS
(seen from medial aspect)

1. mamillary nuclei.
2. posterior nucleus.
3. dorsomedial nucleus.
4. paraventricular nucleus.
5. fibres of the column of the fornix.
6. anterior commissure.
7. pre-optic nucleus.
8. supra-optic nucleus.
9. optic chiasma.
10. tuber cinereum.
11. infundibulum.
12. anterior lobe of pituitary.
13. posterior lobe of pituitary.
14. infundibular nucleus.
15. ventromedial nucleus.
16. lateral nucleus (largest).

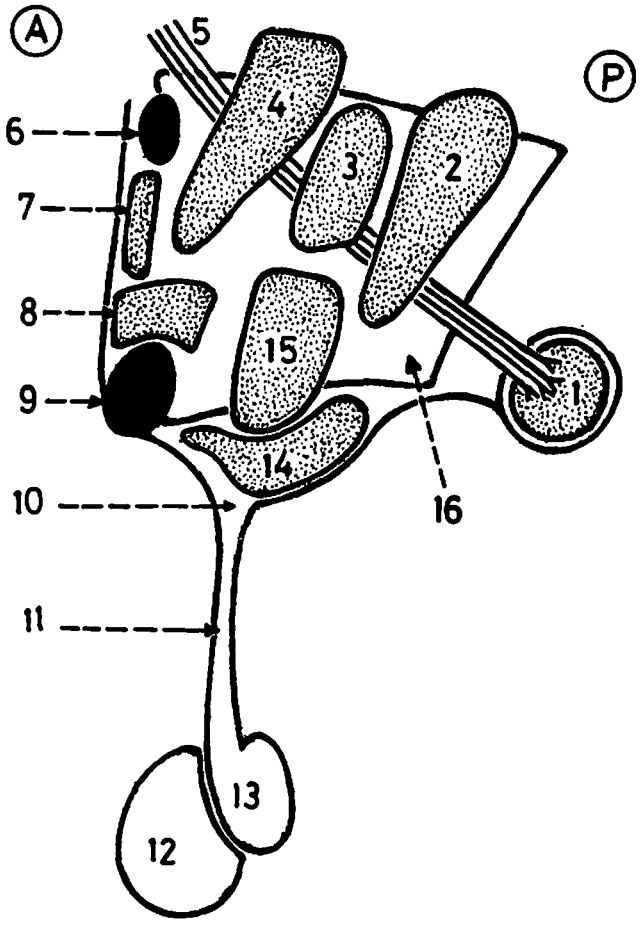
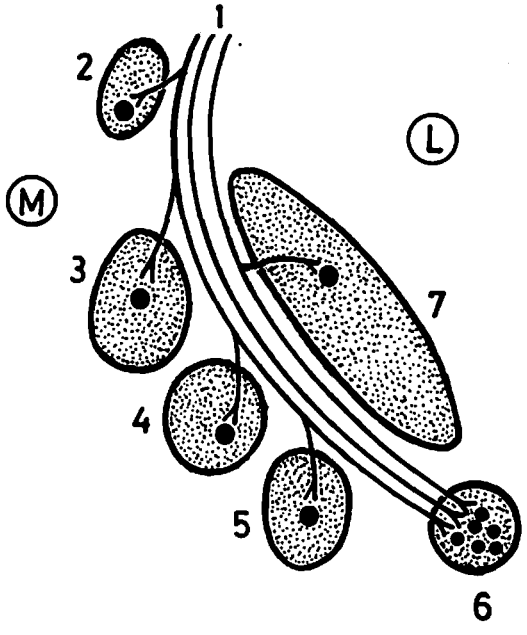


Fig.(220): NUCLEI OF HYPOTHALAMUS
(seen from above)

1. column of the fornix.
2. pre-optic nucleus.
3. paraventricular nucleus.
4. dorsomedial nucleus.
5. posterior nucleus.
6. mamillary nuclei.
7. lateral nucleus.



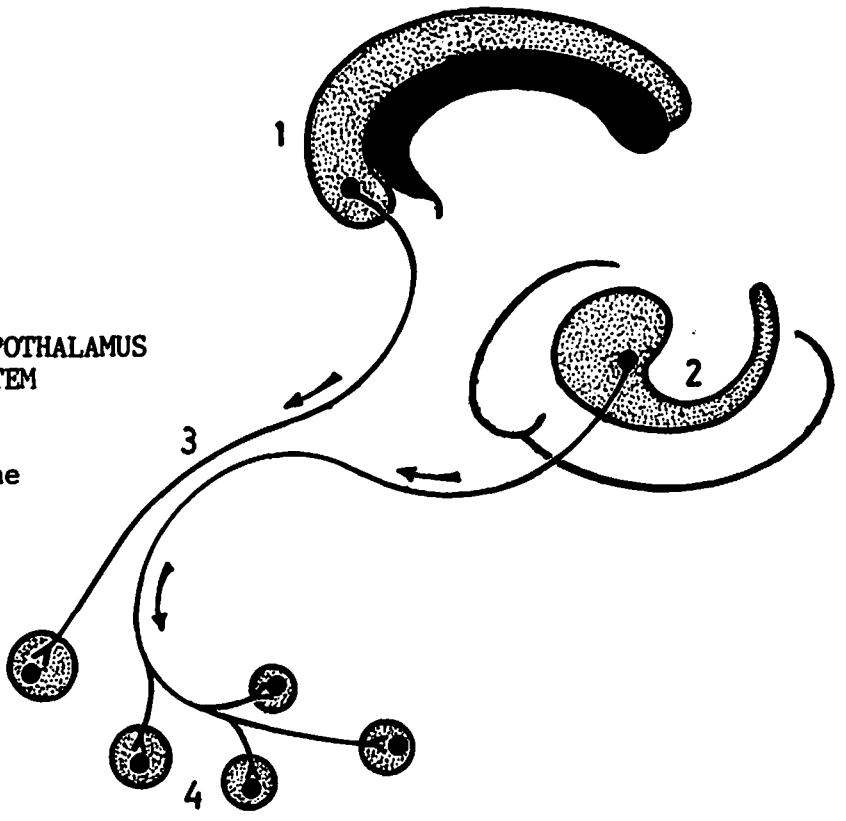


Fig.(221): AFFERENTS TO HYPOTHALAMUS FROM LIMBIC SYSTEM

The limbic system in this figure is represented by the cingulate gyrus and hippocampus.

1. cingulate gyrus.
2. hippocampus.
3. fibres of the column of the fornix.
4. hypothalamic nuclei.

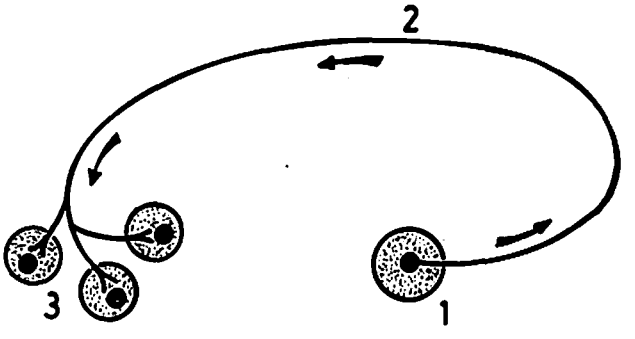


Fig.(222): AFFERENTS TO HYPOTHALAMUS FROM THE AMYGDALOID BODY

1. amygdaloid body.
2. stria terminalis.
3. hypothalamic nuclei.

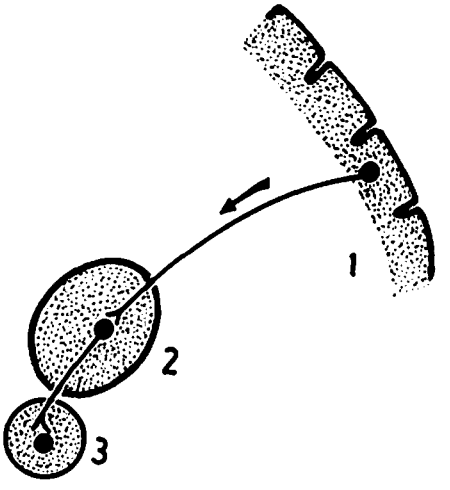


Fig.(223): AFFERENTS TO HYPOTHALAMUS FROM PREFRONTAL CORTEX

The prefrontal cortex is connected with the hypothalamus through the medial nucleus of thalamus.

1. prefrontal cortex.
2. medial nucleus of thalamus.
3. hypothalamus.

Fig.(224): EFFERENT FIBRES FROM HYPOTHALAMUS

These efferents pass to the cingulate gyrus (part of limbic system) and to the reticular formation in the midbrain.

1. cingulate gyrus.
2. anterior nucleus of thalamus.
3. mamillothalamic tract.
4. mamillary body.
5. mamillotegmental tract (to the tegmentum of midbrain).
6. medial forebrain bundle.
7. dorsal longitudinal fasciculus.
8. reticular formation in the tegmentum of midbrain.

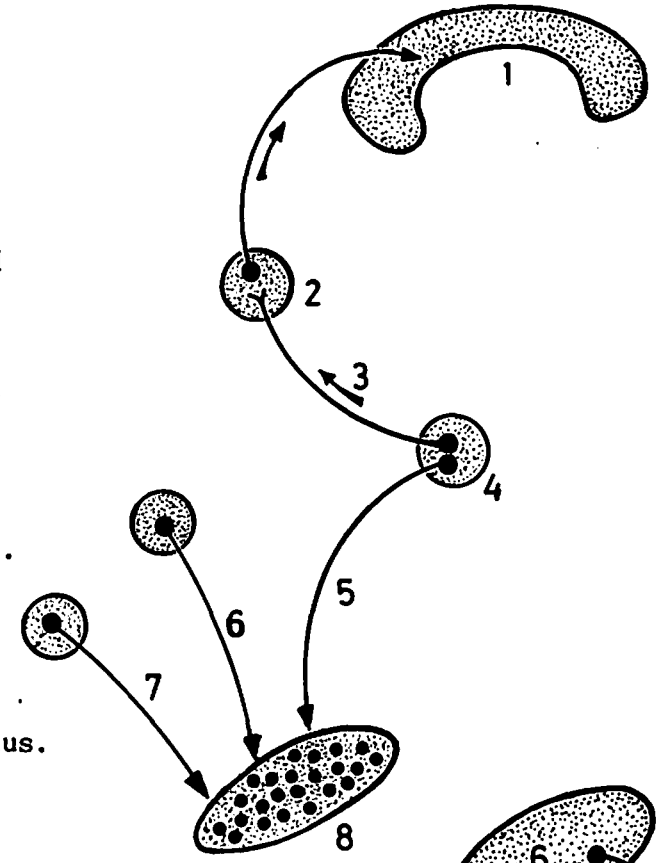
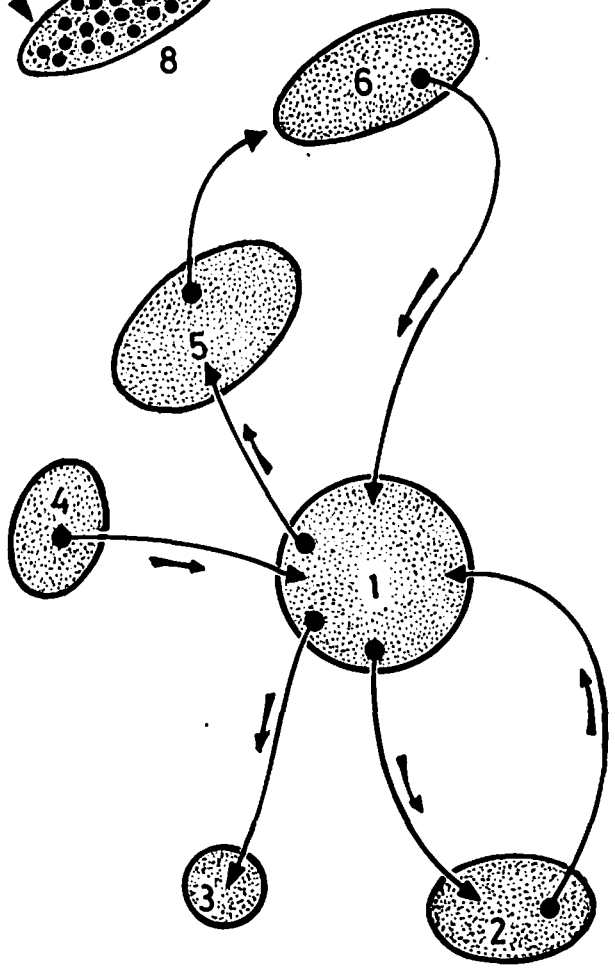


Fig.(225): HYPOTHALAMIC INFLOW AND OUTFLOW

1. hypothalamus.
2. lower autonomic centres in the brainstem and spinal cord.
3. pituitary gland.
4. medial nucleus of thalamus.
5. anterior nucleus of thalamus.
6. limbic system (mainly the cingulate gyrus and hippocampus).



THIRD VENTRICLE

Fig.(226): POSITION OF 3rd VENTRICLE

It is a narrow cavity between the 2 thalami. It communicates with the 2 lateral ventricles through the inter-ventricular foramina and with the 4th ventricle through the cerebral aqueduct.

1. roof of 3rd ventricle (ependyma).
2. thalamus.
3. hypothalamic sulcus.
4. vertical part of hypothalamus.
5. cavity of 3rd ventricle.
6. floor of 3rd ventricle (horizontal part of hypothalamus).

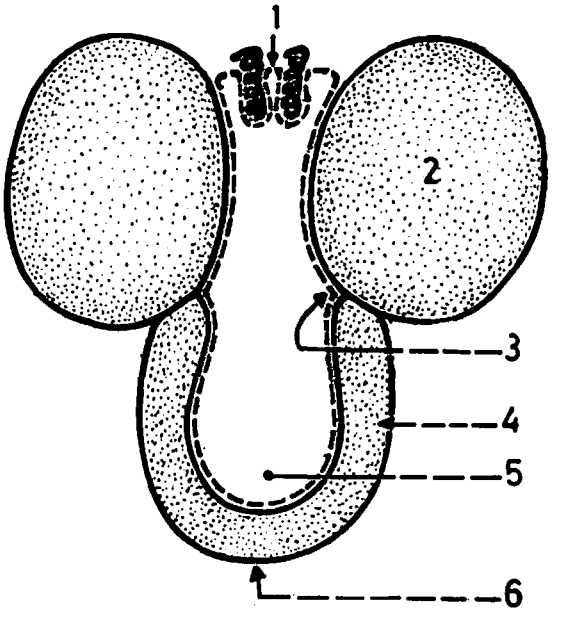


Fig.(227): INTERTHALAMIC ADHESION

It is a limited area of fusion between the 2 thalami across the cavity of the 3rd ventricle.

1. 3rd ventricle.
2. thalamus.
3. floor of 3rd ventricle.
4. interthalamic adhesion.

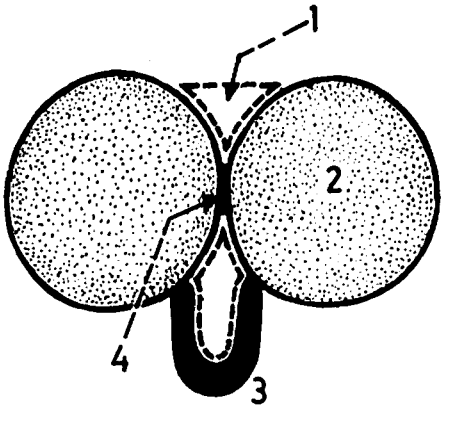
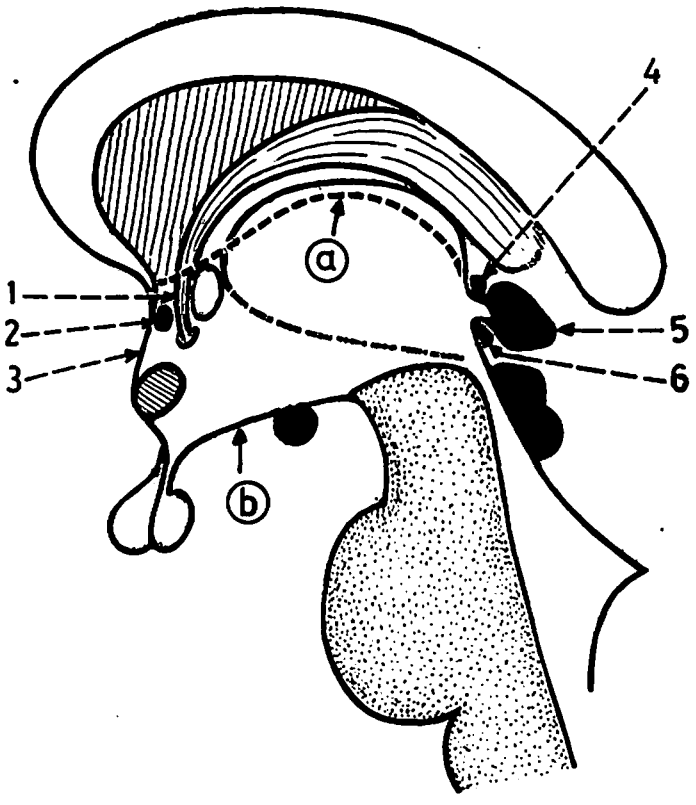


Fig.(228): ANTERIOR AND POSTERIOR WALLS OF 3rd VENTRICLE



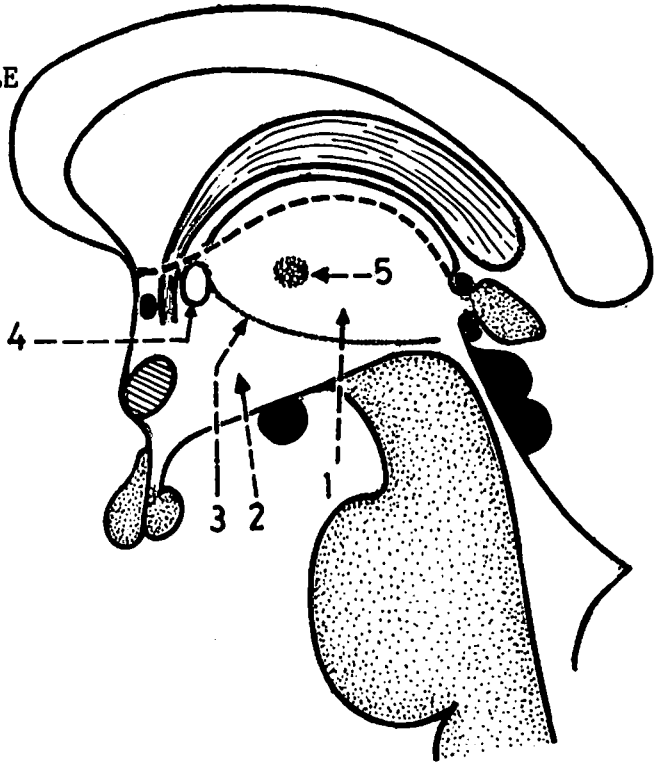
The anterior wall is formed by the lamina terminalis, anterior commissure and the 2 columns of the fornix. The posterior wall is formed by the stalk of the pineal body, habenular commissure and posterior commissure.

1. column of the fornix.
2. anterior commissure.
3. lamina terminalis.
4. habenular commissure (in the upper lamina of the pineal stalk).
5. pineal body.
6. posterior commissure (in the lower lamina of the pineal stalk).

(a) line of the roof of the ventricle.

(b) floor of the ventricle.

Fig.(229): LATERAL WALL OF 3rd VENTRICLE



It is formed by medial surface of thalamus, vertical part of hypothalamus, hypothalamic sulcus, interventricular foramen and interthalamic adhesion.

1. thalamus.
2. hypothalamus.
3. hypothalamic sulcus.
4. interventricular foramen.
5. interthalamic adhesion.

Fig.(230): ROOF OF 3rd VENTRICLE

It is formed by a layer of ependyma stretched between the 2 thalami. It is invaginated by the tela choroidea of 3rd ventricle which contains the choroid plexuses and 2 internal cerebral veins.

1. choroid plexus.
2. pia mater forming the tela choroidea.
3. ependyma of the roof.

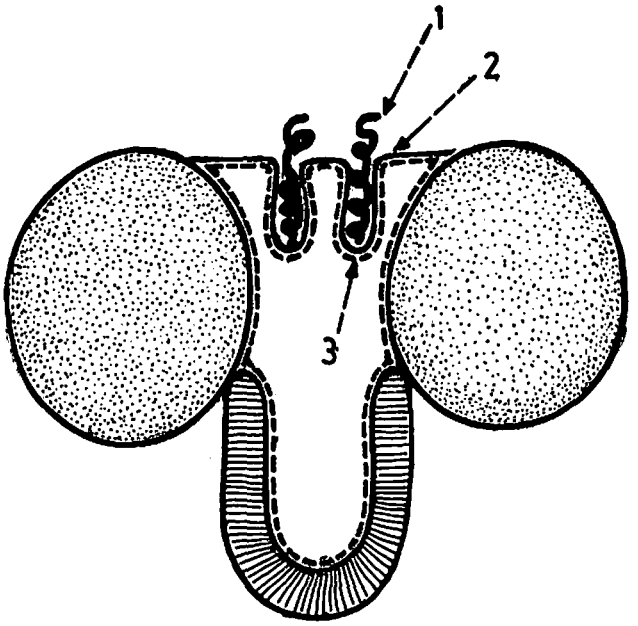
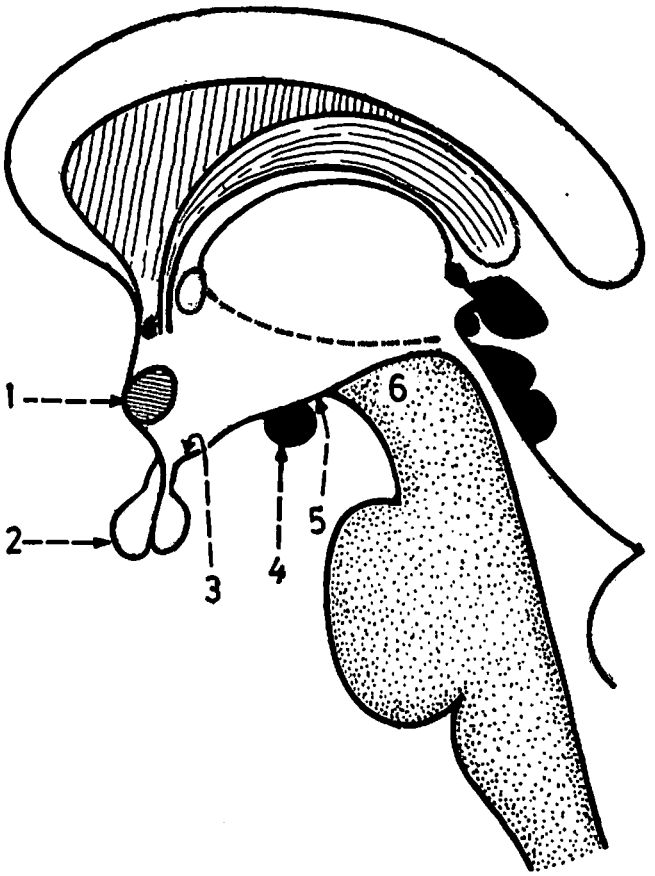


Fig.(231): FLOOR OF 3rd VENTRICLE

It is formed from before backwards by: optic chiasma, tuber cinereum and infundibulum, 2 mamillary bodies, posterior perforated substance and tegmentum of midbrain.

1. optic chiasma.
2. pituitary gland.
3. tuber cinereum.
4. mamillary body.
5. posterior perforated substance.
6. tegmentum of midbrain.

* Most of the structures in the floor of the 3rd ventricle are parts of the hypothalamus.



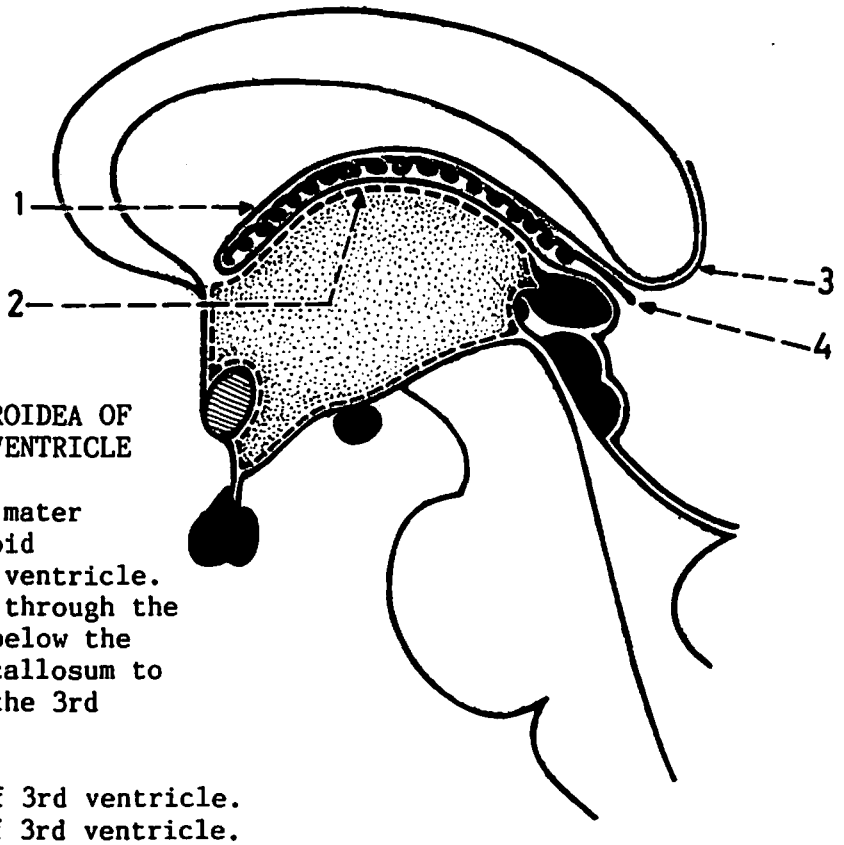


Fig.(232): TELA CHOROIDEA OF THE 3rd VENTRICLE

It is a fold of pia mater containing the choroid plexuses of the 3rd ventricle. It extends forwards through the transverse fissure below the splenium of corpus callosum to lie in the roof of the 3rd ventricle.

1. tela choroidea of 3rd ventricle.
2. ependymal roof of 3rd ventricle.
3. pia mater covering the splenium of corpus callosum.
4. choroidal plexus of arteries passing through the transverse fissure below the splenium of corpus callosum.

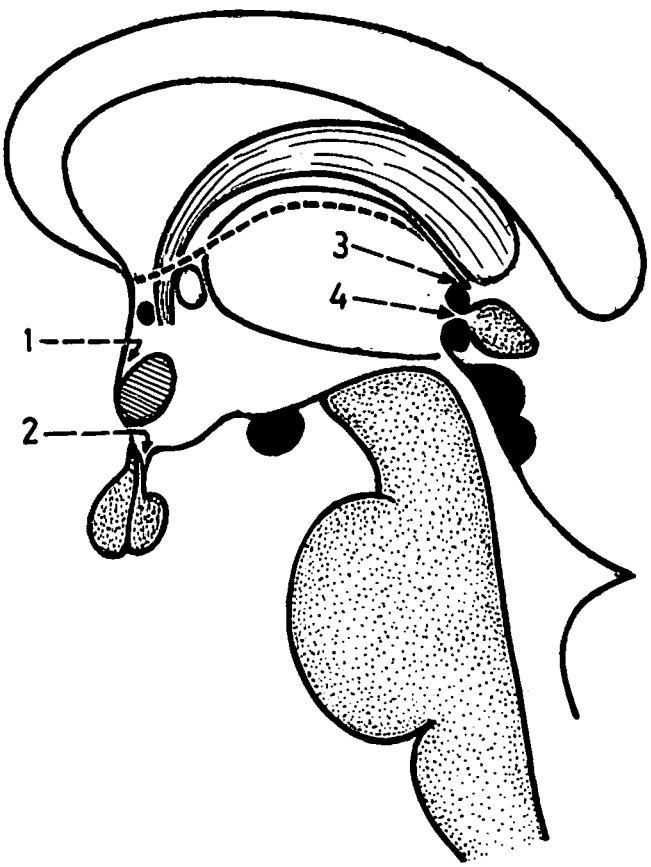


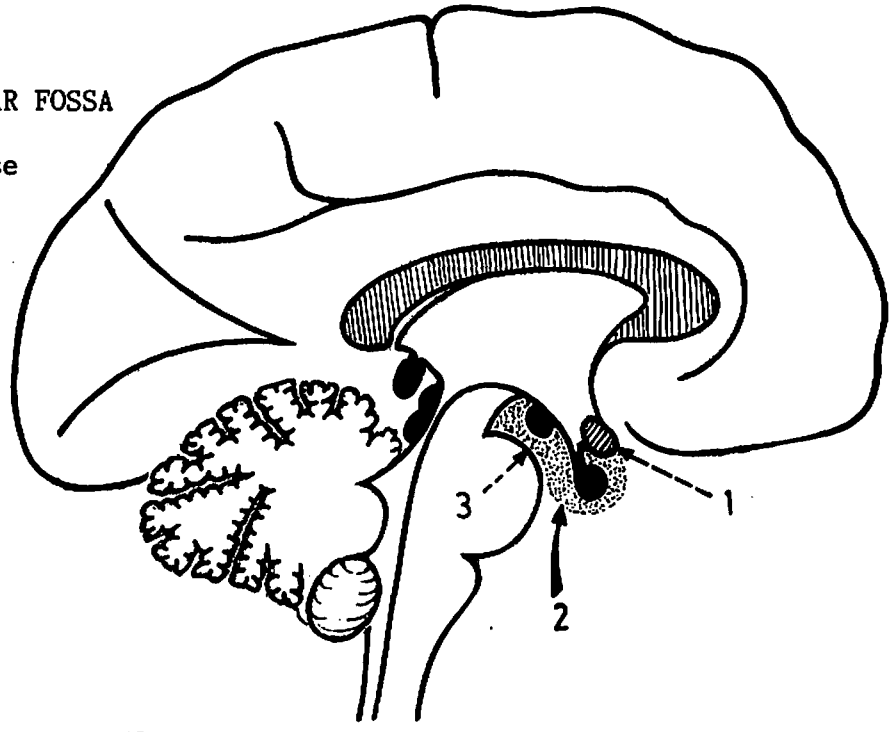
Fig.(233): RECESSES OF 3rd VENTRICLE

These recesses are: infundibular, optic, pineal and suprapineal.

1. optic recess: just in front of the optic chiasma.
2. infundibular recess: in the upper part of the infundibulum.
3. suprapineal recess: just above the pineal body.
4. pineal recess: in the stalk of the pineal body.

INTERPEDUNCULAR FOSSA

Fig.(234): POSITION OF INTERPEDUNCULAR FOSSA

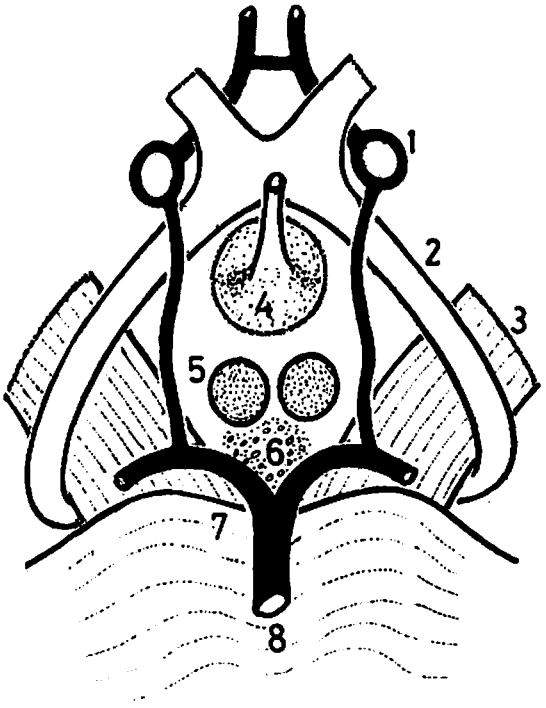


It is situated in the base of the brain between the optic chiasma in front, and the upper edge of the basilar part of the pons behind.

1. optic chiasma (anterior boundary).
2. interpeduncular fossa.
3. upper edge of the basilar part of the pons (posterior boundary).

Fig.(235): BOUNDARIES AND CONTENTS OF INTERPEDUNCULAR FOSSA

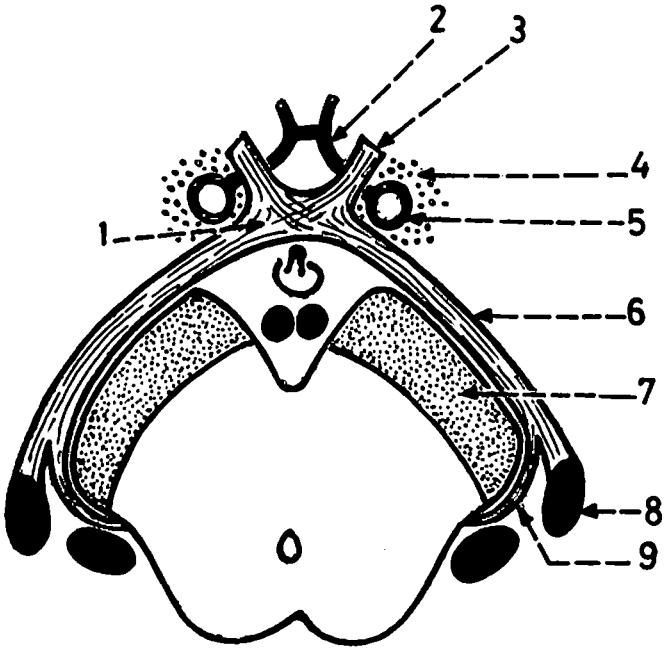
The fossa is bounded in front by the optic chiasma and behind by the upper edge of the basilar part of the pons. On each side there are an optic tract and a crus cerebri.
The contents of the fossa are: tuber cinereum, infundibulum, mamillary bodies, posterior perforated substance, oculomotor nerves and arteries of the circle of Willis.



1. internal carotid artery (lateral to the optic chiasma).
2. optic tract (anterolateral boundary).
3. crus cerebri (posterolateral boundary).
4. tuber cinereum and infundibulum.
5. mamillary bodies.
6. posterior perforated substance.
7. upper edge of the basilar part of pons (posterior boundary).
8. basilar artery.

OPTIC CHIASMA AND TRACT

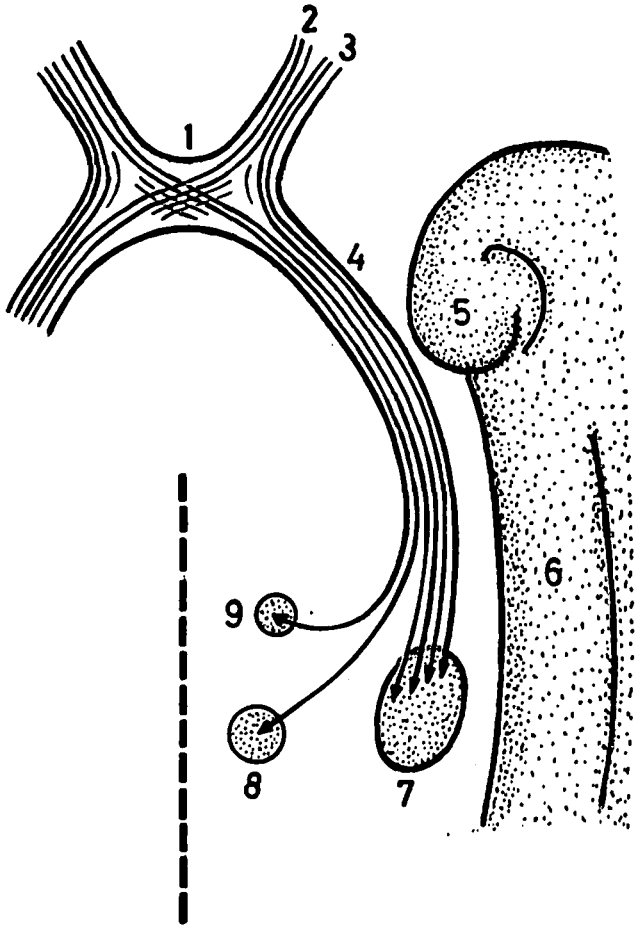
Fig.(236): POSITION OF OPTIC CHIASMA AND TRACT



The optic chiasma is an X-shaped bundle of fibres which is continuous in front with the 2 optic nerves and behind with the 2 optic tracts.
The optic tract lies between the anterior perforated substance laterally and the tuber cinereum medially, and crosses over the uppermost part of the crus cerebri. It ends posteriorly in the lateral geniculate body.

1. optic chiasma.
2. anterior cerebral artery passing above the optic chiasma.
3. optic nerve.
4. anterior perforated substance lateral to the optic chiasma and beginning of the optic tract.
5. termination of internal carotid artery.
6. optic tract.
7. crus cerebri of midbrain.
8. lateral geniculate body.
9. part of the optic tract carrying fibres to the pretectal nucleus and superior colliculus (for visual reflexes).

Fig.(237): DISTRIBUTION OF FIBRES OF THE OPTIC TRACT



They are distributed to the lateral geniculate body, superior colliculus and pretectal nucleus.

1. optic chiasma (decussation of nasal fibres).
2. nasal fibres of optic nerve.
3. temporal fibres of optic nerve.
4. optic tract.
5. uncus of temporal lobe.
6. parahippocampal gyrus.
7. lateral geniculate body.
8. superior colliculus.
9. pretectal nucleus.

LOBES OF CEREBRAL HEMISPHERE

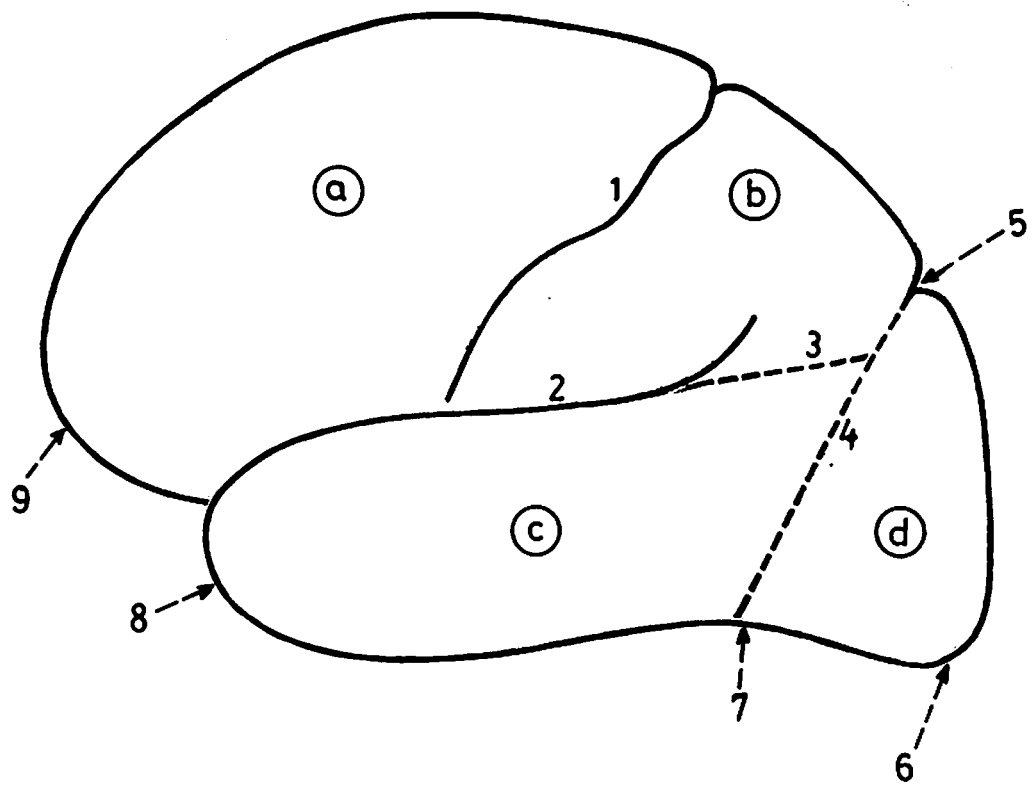


Fig.(238): LOBES OF THE CEREBRAL HEMISPHERE
(superolateral surface)

The cerebral hemisphere consists of 4 lobes: frontal, parietal, temporal and occipital.

(a) Frontal lobe: bounded in front by the frontal pole and behind by the central sulcus.

(b) Parietal lobe: bounded in front by the central sulcus, and behind by a line drawn from the parieto-occipital sulcus to the pre-occipital notch.

(c) Temporal lobe: bounded in front by the temporal pole, behind by the line drawn from the parieto-occipital sulcus to the pre-occipital notch, and above by the posterior ramus of the lateral sulcus.

(d) Occipital lobe: bounded in front by the line drawn from the parieto-occipital sulcus to the pre-occipital notch, and behind by the occipital pole.

1. central sulcus.
2. posterior ramus of lateral sulcus.
3. posterior extension of the posterior ramus of lateral sulcus (separates the parietal lobe from the temporal lobe).
4. a line drawn from the parieto-occipital sulcus to the pre-occipital notch.
5. parieto-occipital sulcus.
6. occipital pole.
7. pre-occipital notch (5 cm in front of the occipital pole).
8. temporal pole.
9. frontal pole.

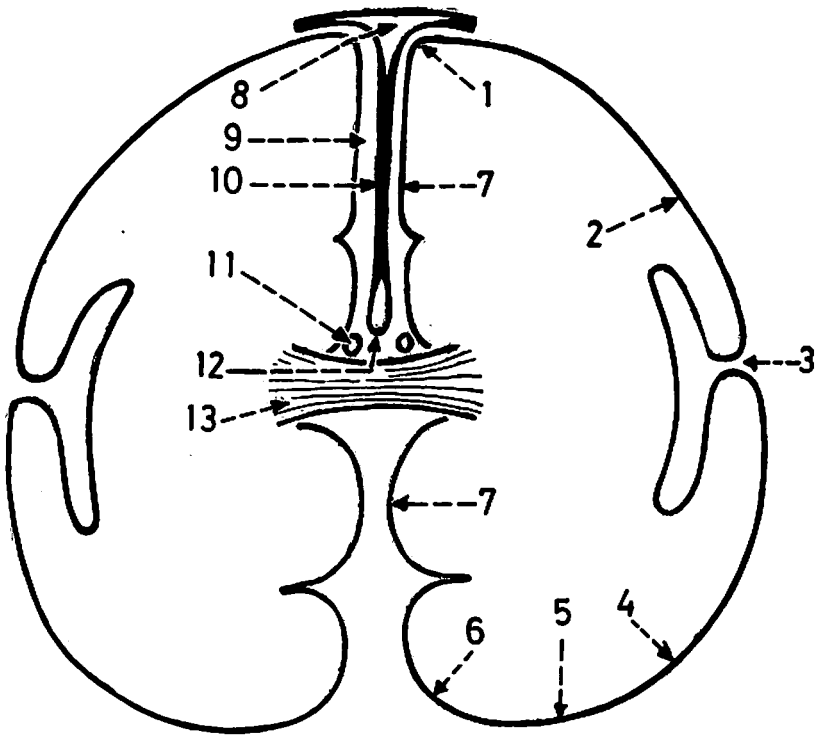


Fig.(239): SURFACES AND BORDERS OF THE CEREBRAL HEMISPHERE
(coronal section)

Each cerebral hemisphere has 3 surfaces (superolateral, medial and inferior), and 3 borders (superomedial, inferolateral and inferomedial).
The medial surfaces of the 2 cerebral hemispheres are separated from each other by the longitudinal cerebral fissure which contains the falx cerebri, corpus callosum and anterior cerebral vessels.

1. superomedial border.
2. superolateral surface.
3. lateral sulcus.
4. inferolateral border.
5. inferior surface.
6. inferomedial border.
7. medial surface.
8. superior sagittal sinus.
9. longitudinal cerebral fissure (between the 2 hemispheres).
10. falx cerebri.
11. anterior cerebral artery.
12. inferior sagittal sinus.
13. corpus callosum.

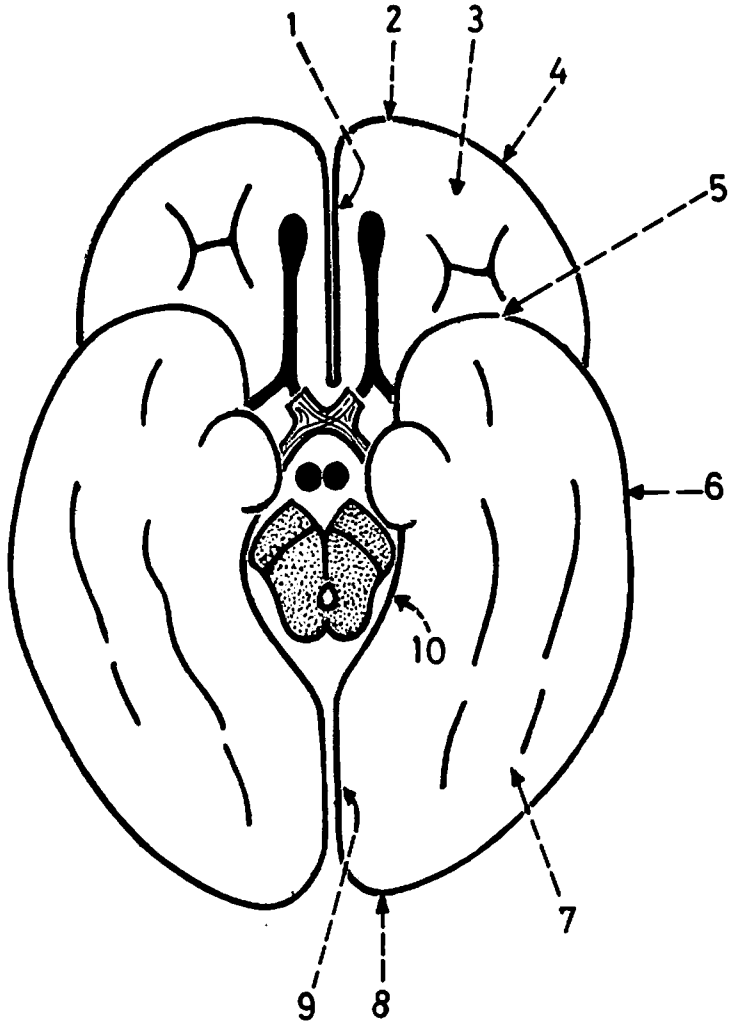


Fig.(240): PARTS AND BORDERS OF THE INFERIOR SURFACE OF THE CEREBRUM

The inferior surface of the brain consists of 2 parts: orbital part in front, and tentorial part behind. The 2 parts are separated from each other by the stem of the lateral sulcus.

1. medial orbital border (part of the inferomedial border).
2. frontal pole.
3. orbital surface (lies over the roof of the orbit).
4. superciliary border (part of the inferolateral border).
5. temporal pole (overlies the stem of the lateral sulcus).
6. inferolateral border.
7. tentorial surface (lies over the tentorium cerebelli).
8. occipital pole.
9. medial occipital border (part of the inferomedial border).
10. hippocampal border (part of the inferomedial border).

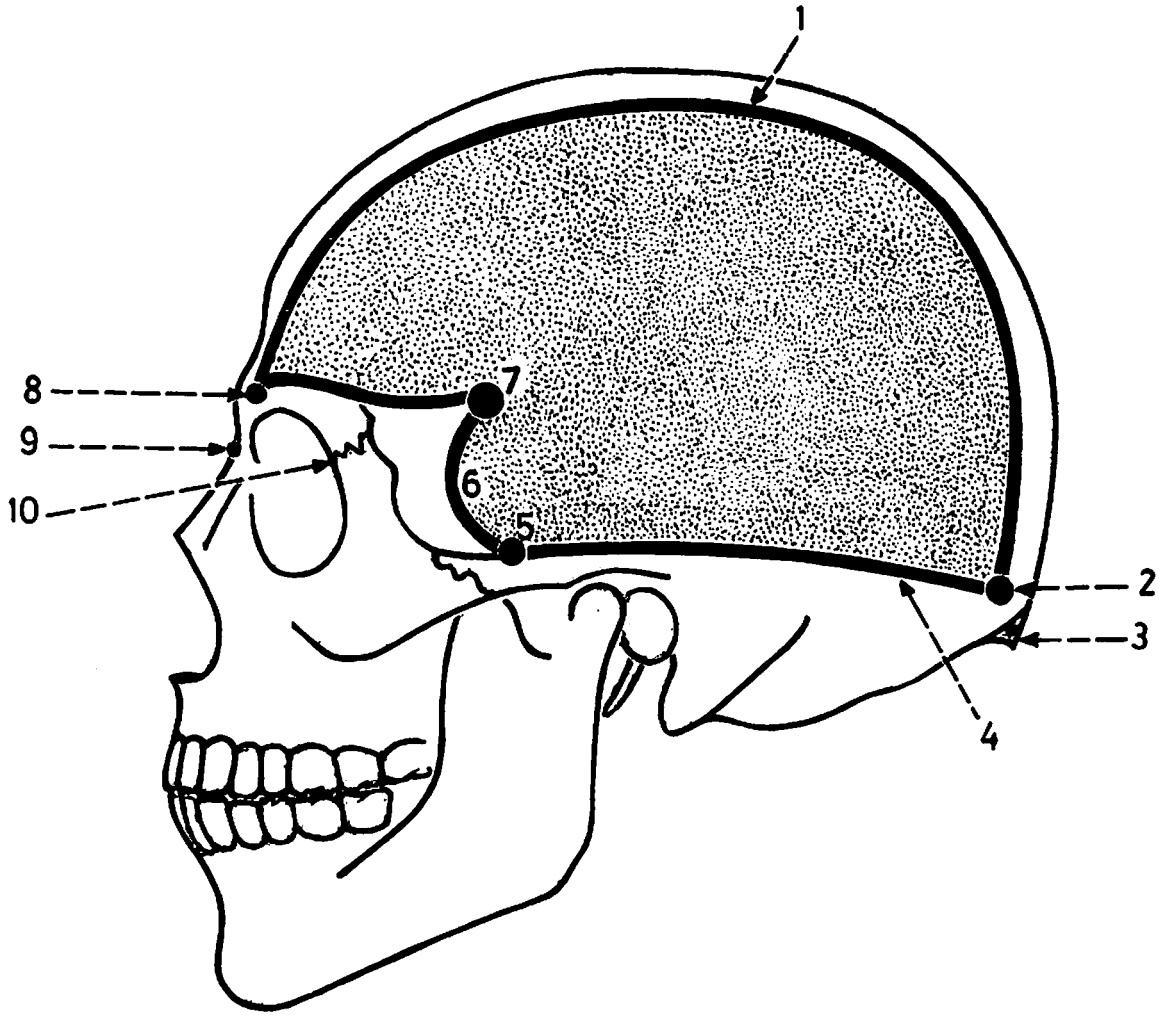


Fig.(241): OUTLINE OF THE CEREBRAL HEMISPHERE AS PROJECTED ON THE SURFACE

1. superolateral border: corresponds to an anteroposterior line extending just lateral to the midline from the glabella to the inion.
2. occipital pole: opposite the inion.
3. inion (a point on the tip of the external occipital protuberance).
4. inferolateral border: corresponds to an anteroposterior line drawn along the upper border of the zygomatic arch.
5. midpoint of the zygomatic arch.
6. temporal pole: corresponds to a convex line drawn from the pterion to the midpoint of the zygomatic arch.
7. pterion (lies 4 cm behind the frontozygomatic suture, and 4 cm above the zygomatic arch).
8. frontal pole: corresponds to the glabella.
9. nasion.
10. frontozygomatic suture (on the lateral margin of the orbit).

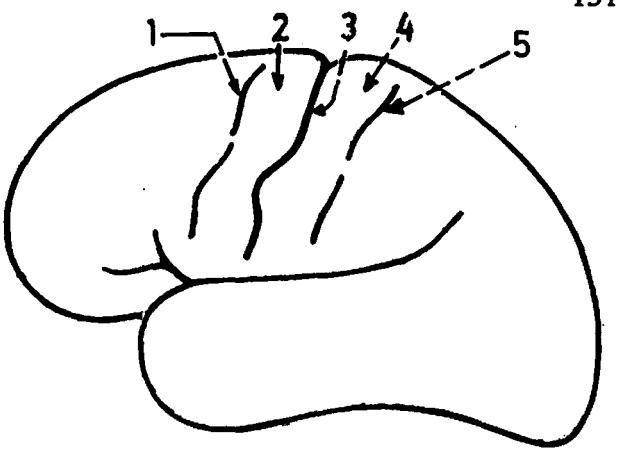


Fig.(242): CENTRAL SULCUS

It begins at the superomedial border midway between the frontal and occipital poles, and passes downwards and forwards on the superolateral surface.

1. precentral sulcus.
2. precentral gyrus.
3. central sulcus.
4. postcentral gyrus.
5. postcentral sulcus.

* The central sulcus separates the frontal lobe from the parietal lobe.

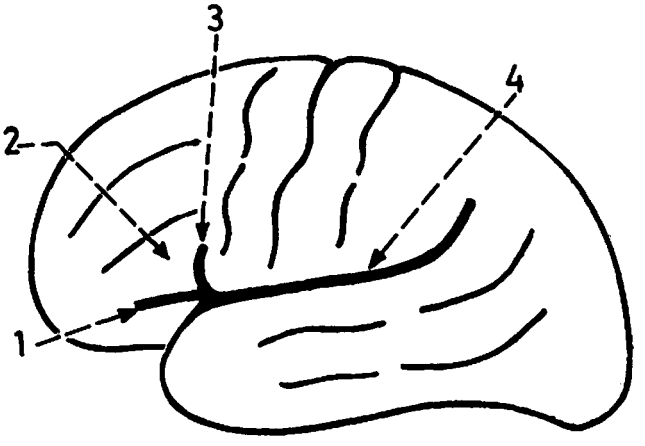


Fig.(243): LATERAL SULCUS

It has a stem on the inferior surface of the brain and 3 rami on the superolateral surface. The 3 rami are: anterior, ascending and posterior.

1. anterior ramus (runs forwards for 2 cm and cuts into the inferior frontal gyrus).
2. inferior frontal gyrus.
3. ascending ramus (runs upwards for 2 cm and cuts into the inferior frontal gyrus).
4. posterior ramus (runs backwards for 8 cm and separates the frontal and parietal lobes above from the temporal lobe below).

* If the lips of the posterior ramus are pulled apart the insula is exposed.

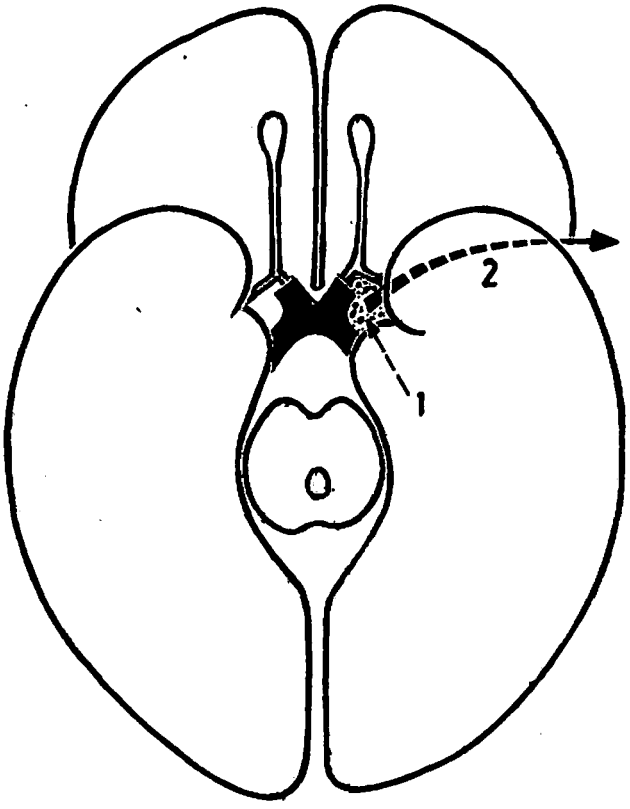


Fig.(244): STEM OF LATERAL SULCUS

It runs transversely on the inferior surface under cover of the temporal pole. It begins medially at the anterior perforated substance, and ends laterally on the superolateral surface by dividing into 3 rami.

1. anterior perforated substance.
2. stem of lateral sulcus.

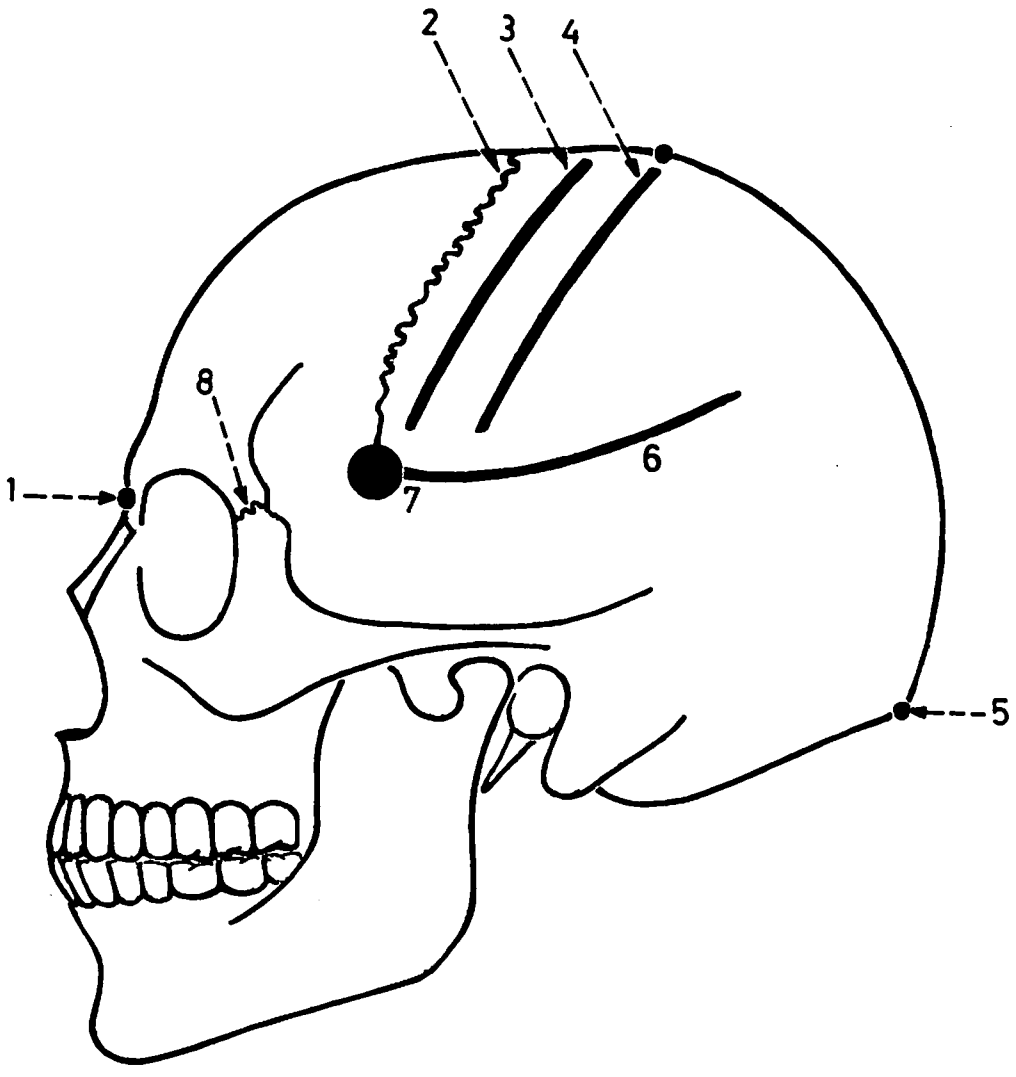


Fig.(245):SURFACE ANATOMY OF THE CENTRAL SULCUS, POSTERIOR RAMUS OF LATERAL SULCUS AND ANTERIOR BRANCH OF MIDDLE MENINGEAL ARTERY

1. nasion.
2. coronal suture.
3. a line representing the anterior branch of middle meningeal artery (one finger breadth behind the coronal suture).
4. a line representing the central sulcus (two fingers breadth behind and parallel to the coronal suture. Its upper end lies midway between the nasion and inion).
5. inion.
6. a line representing the posterior ramus of lateral sulcus (passes backwards and slightly upwards for 8 cm behind the pterion).
7. pterion (lies 4 cm behind the frontozygomatic suture and 4 cm above the zygomatic arch).
8. frontozygomatic suture.

* The pterion marks the lower end of the coronal suture, anterior end of the posterior ramus of lateral sulcus and the site where the anterior branch of middle meningeal artery grooves the bone deeply.

SULCI AND GYRI OF SUPEROLATERAL SURFACE

Fig.(246): SULCI AND GYRI OF FRONTAL LOBE

1. superior frontal gyrus.
2. middle frontal gyrus.
3. inferior frontal gyrus (receives the anterior and ascending rami of lateral sulcus).
4. motor speech area (Broca's area).
5. precentral sulcus.
6. precentral gyrus (motor area).
7. central sulcus.

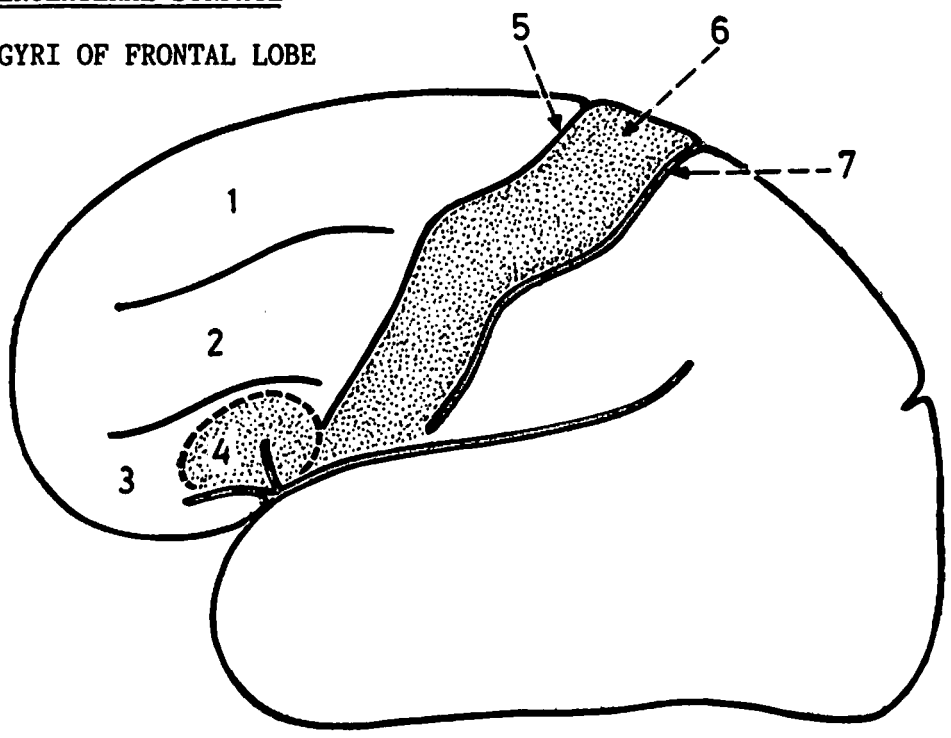


Fig.(247): SULCI AND GYRI OF PARIETAL LOBE

1. central sulcus.
2. postcentral gyrus (somatosensory area).
3. postcentral sulcus.
4. superior parietal lobule.
5. intraparietal sulcus.
6. supramarginal gyrus (arches over the end of the posterior ramus of lateral sulcus).
7. angular gyrus (arches over the end of the superior temporal sulcus).
8. arcus parieto-occipitalis (arches over the parieto-occipital sulcus).
9. inferior parietal lobule (below the intraparietal sulcus).
10. superior temporal sulcus.
11. inferior temporal sulcus.

* The area of the parietal lobe behind the postcentral sulcus is divided by the intra-parietal sulcus into superior parietal lobule and inferior parietal lobule.

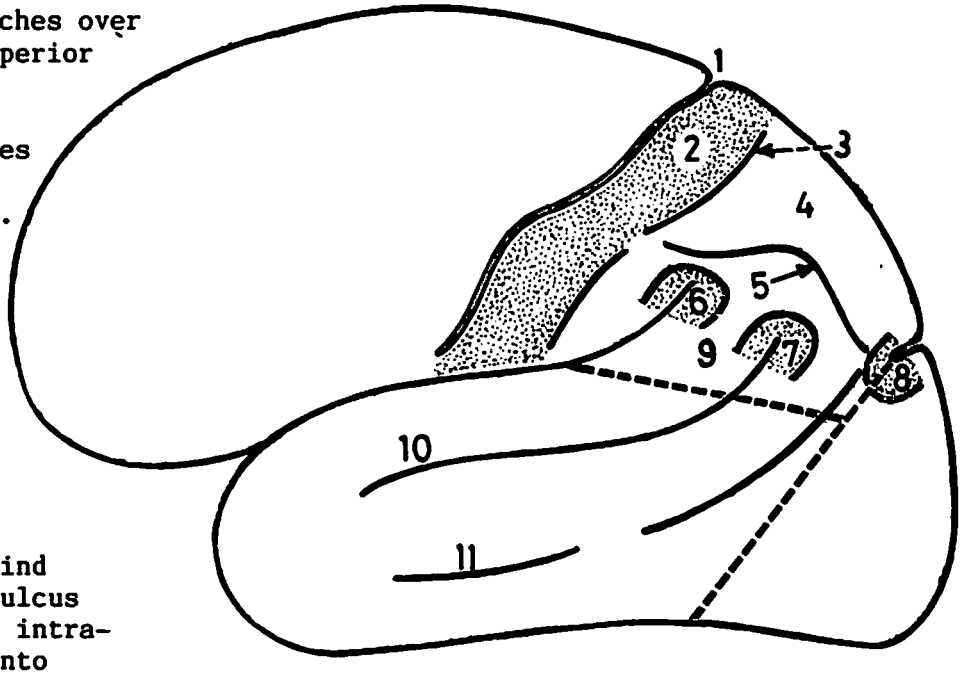


Fig.(248): SULCI AND GYRI OF TEMPORAL LOBE

1. superior temporal gyrus (the auditory area lies in its middle).
2. middle temporal gyrus.
3. inferior temporal gyrus.
4. posterior ramus of lateral sulcus.
5. superior temporal sulcus.
6. inferior temporal sulcus.

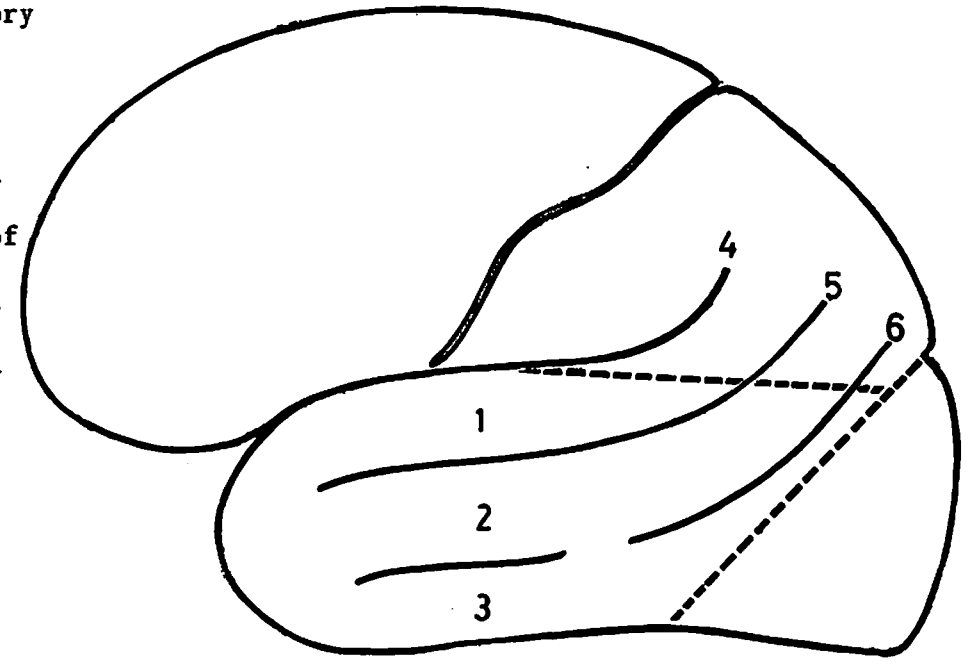
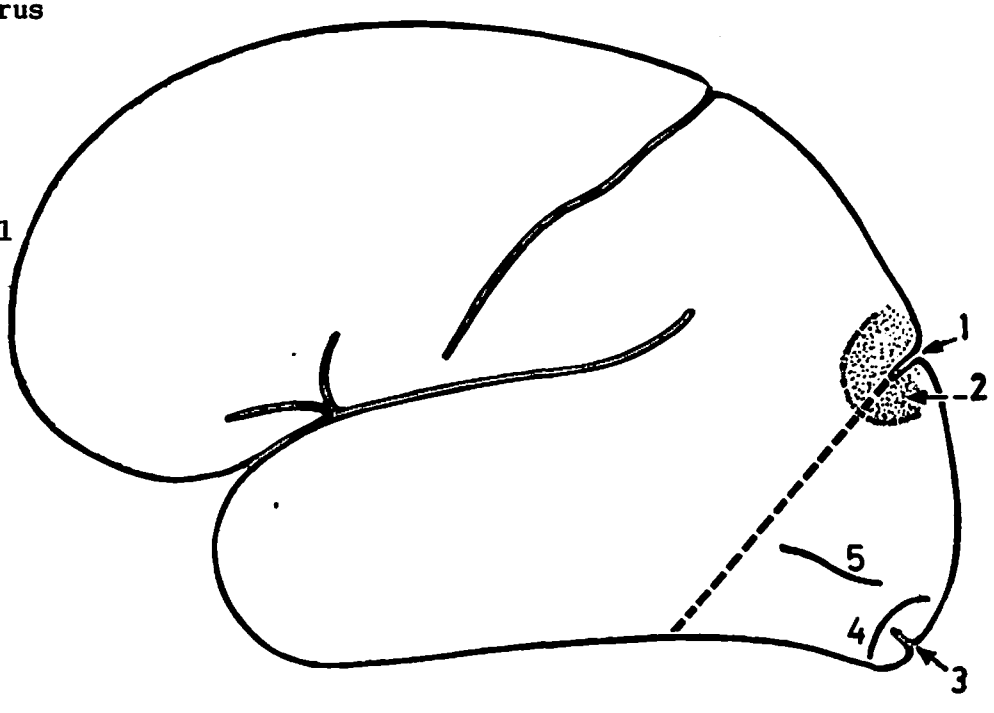


Fig.(249): SULCI AND GYRI OF OCCIPITAL LOBE

1. parieto-occipital sulcus.
2. arcus parieto-occipitalis (a gyrus which arches over the end of parieto-occipital sulcus).
3. end of calcarine sulcus cutting into the occipital pole.
4. lunate sulcus.
5. lateral occipital sulcus.



INSULA

Fig.(250): POSITION AND OUTLINE OF THE INSULA

The insula is a buried part of the cerebral cortex in the bottom of the lateral sulcus. It is triangular in outline and the edges of the lateral sulcus forms its opercula.

1. frontal operculum (between the anterior and ascending rami of the lateral sulcus).
2. frontoparietal operculum (upper lip of the posterior ramus of lateral sulcus).
3. temporal operculum (lower lip of the posterior ramus of lateral sulcus).
4. outline of the insula (triangular).

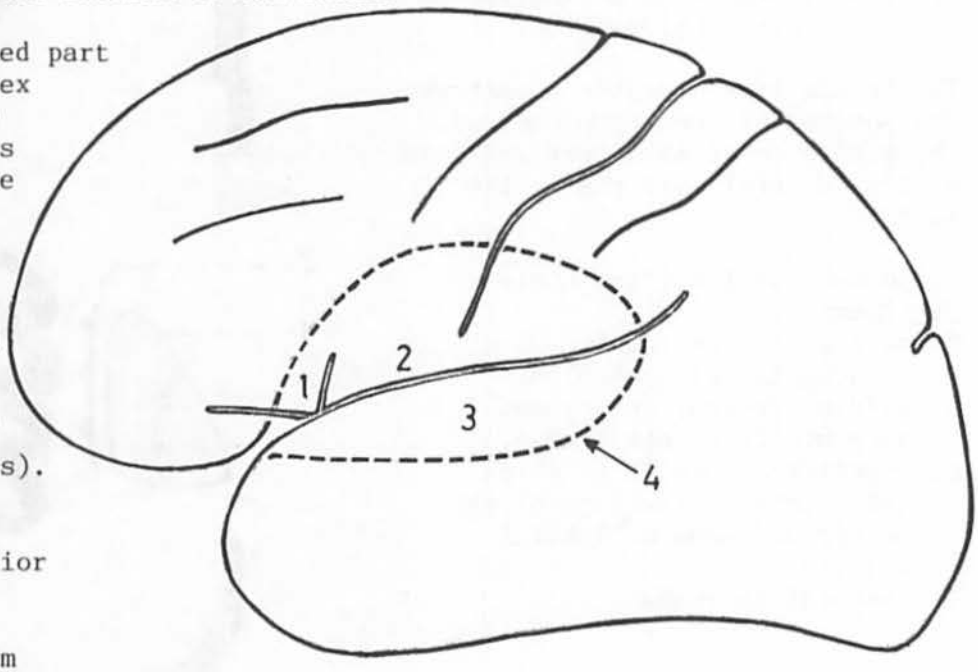


Fig.(251): SULCI AND GYRI OF THE INSULA

The surface of the insula has a number of gyri and sulci which radiate from its apex. The whole area of the insula is surrounded by a circular sulcus.

1. short gyrus.
2. cut edge of the opercula.
3. circular sulcus surrounding the gyri of the insula.
4. apex of the insula (called limen insulae).
5. long gyrus divided at its upper end.

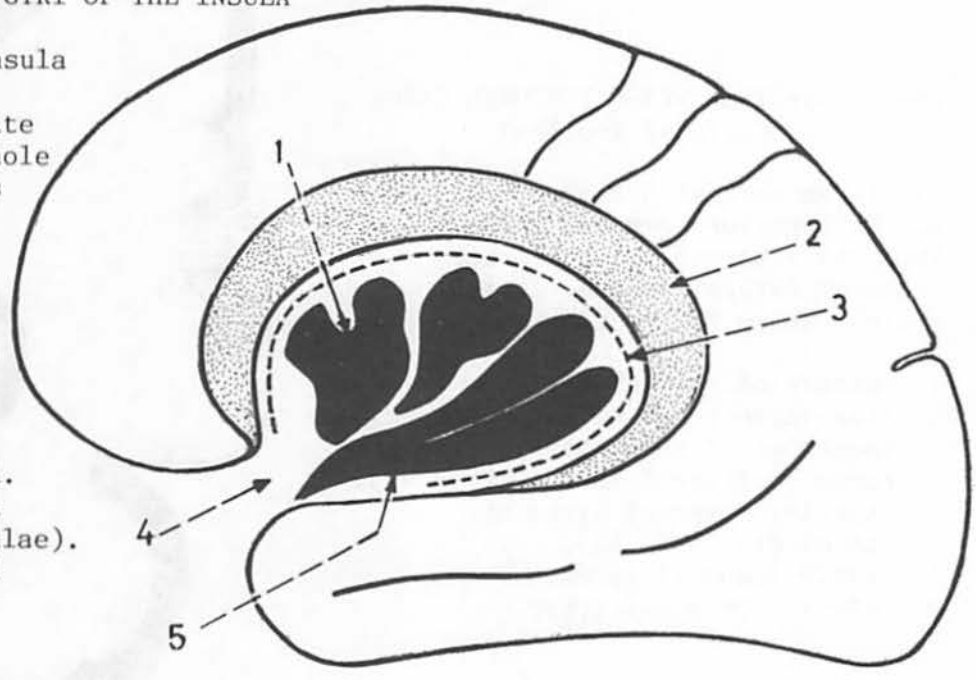


Fig.(252): RELATIONS OF THE INSULA
(coronal section)

The insula lies over the claustrum and putamen of lentiform nucleus. The middle cerebral artery and deep middle cerebral vein run on its surface.

1. putamen of lentiform nucleus.
2. claustrum.
3. surface of the insula.
4. frontoparietal operculum.
5. middle cerebral artery and deep middle cerebral vein.
6. superficial middle cerebral vein (between the lips of the posterior ramus of lateral sulcus).
7. temporal operculum.

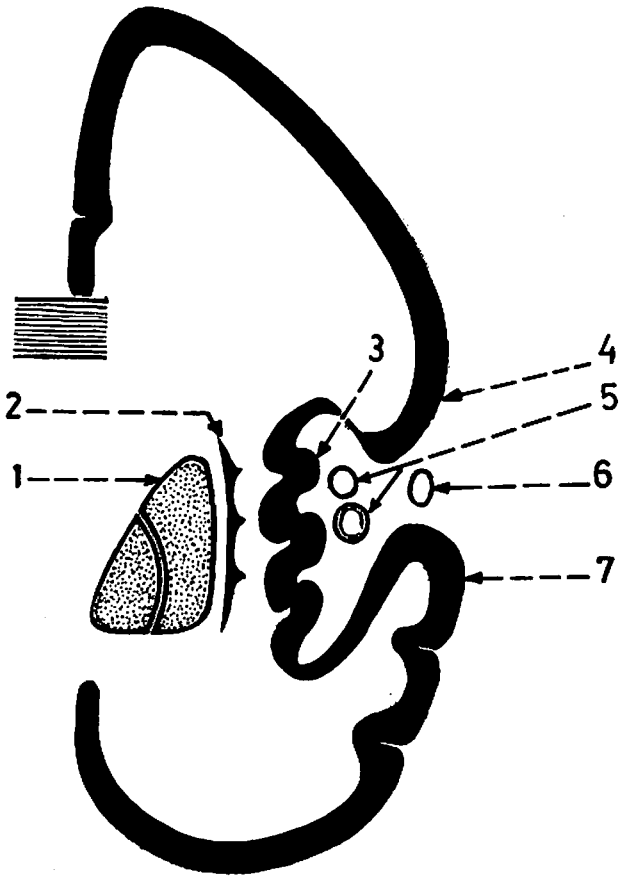
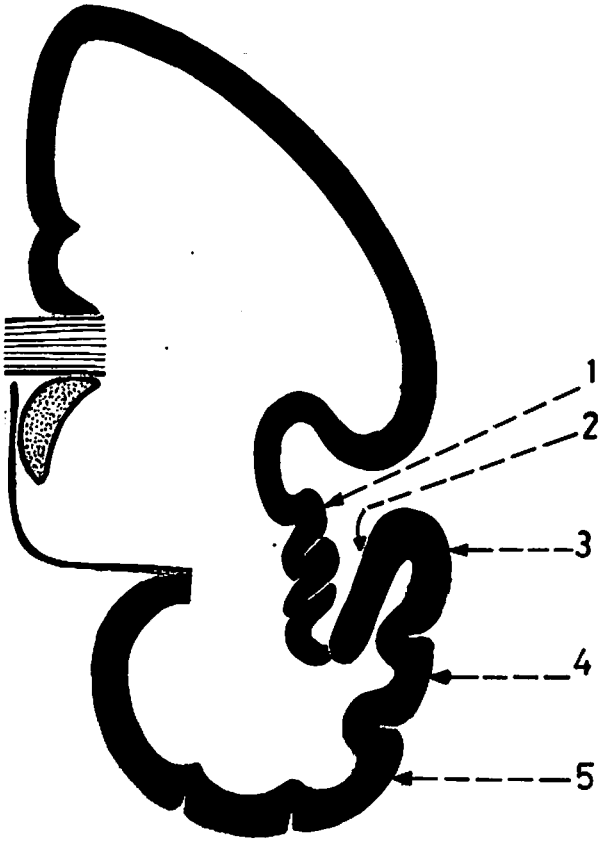


Fig.(253): TRANSVERSE TEMPORAL GYRUS
(coronal section)

It is an extension from the middle of the superior temporal gyrus into the floor of the posterior ramus of lateral sulcus. It is a high centre for hearing (area 41).

1. surface of the insula.
2. transverse temporal gyrus in the floor of the posterior ramus of lateral sulcus (area 41).
3. superior temporal gyrus at its middle (area 42).
4. middle temporal gyrus.
5. inferior temporal gyrus.



SULCI AND GYRI OF MEDIAL SURFACE

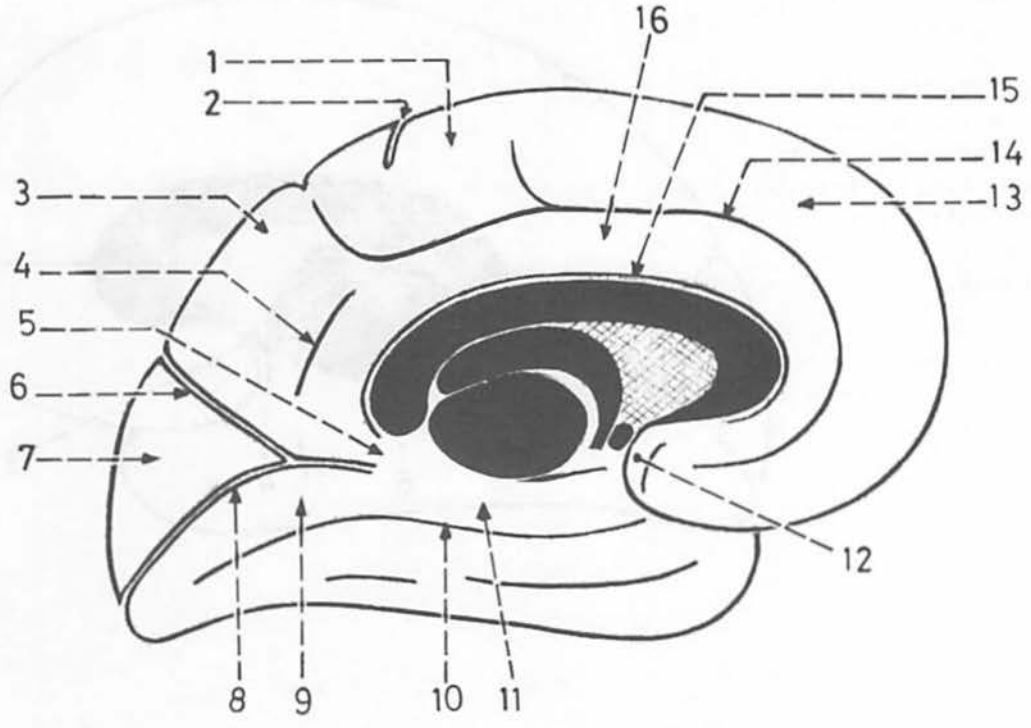


Fig.(254): SULCI AND GYRI OF MEDIAL SURFACE

The medial surface of the cerebral hemisphere differs from the other surfaces in that its central part does not contain sulci and gyri.

1. paracentral lobule (the area which arches over the terminal part of the central sulcus on the medial surface).
2. terminal part of central sulcus which extends onto the medial surface.
3. precuneus (in front of the cuneus).
4. suprasplenial sulcus.
5. isthmus (just behind the splenium of the corpus callosum).
6. parieto-occipital sulcus.
7. cuneus.
8. calcarine sulcus.
9. lingual gyrus (below the calcarine sulcus).
10. collateral sulcus (on the inferior surface).
11. parahippocampal gyrus.
12. paraterminal gyrus (in front of the lamina terminalis).
13. medial frontal gyrus.
14. cingulate sulcus.
15. callosal sulcus.
16. cingulate gyrus.

Fig.(255): CENTRAL AREA OF THE MEDIAL SURFACE

It does not contain sulci or gyri.

1. septum pellucidum.
2. corpus callosum.
3. anterior commissure.
4. column of the fornix.
5. interventricular foramen.
6. thalamus.

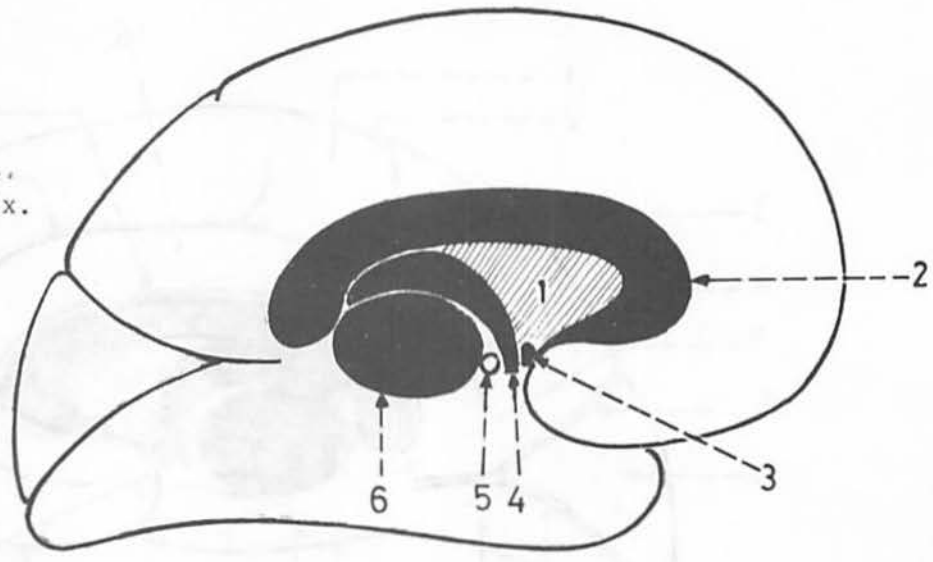


Fig.(256): LOBES OF THE CEREBRUM AS SEEN ON THE MEDIAL SURFACE

1. limbic lobe.
2. frontal lobe.
3. parietal lobe.
4. occipital lobe.
5. temporal lobe.

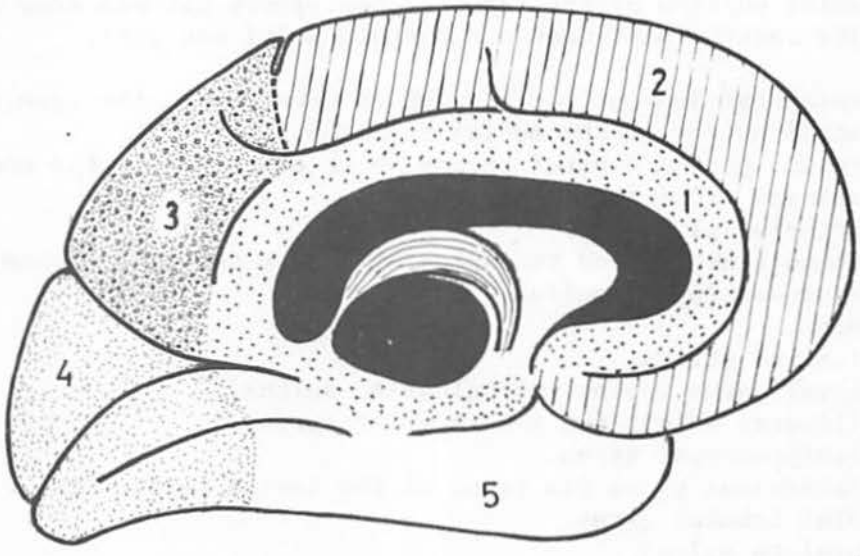
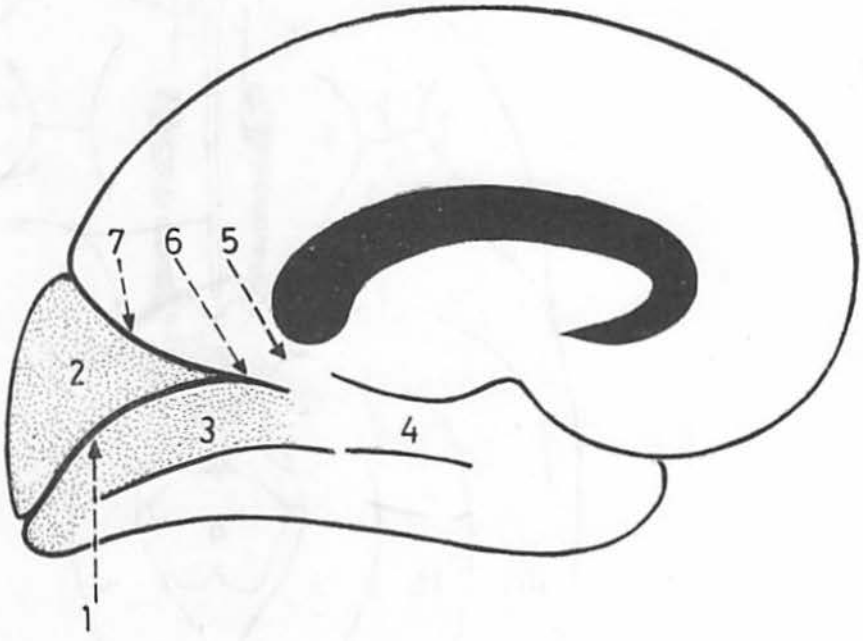


Fig.(257): CALCARINE SULCUS

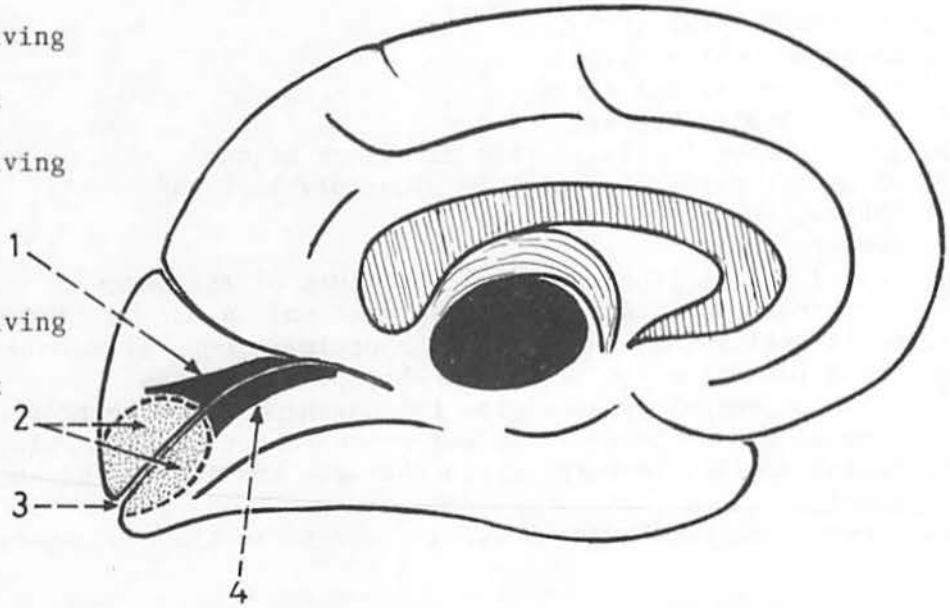
It is a deep sulcus situated mainly on the medial surface but its posterior end reaches the lateral surface. Its anterior part lies between the isthmus and lingual gyrus, while its posterior part lies between the cuneus and lingual gyrus.



1. posterior part of of calcarine sulcus.
2. cuneus.
3. lingual gyrus.
4. parahippocampal gyrus (anterior continuation of the lingual gyrus.
5. isthmus.
6. anterior part of calcarine sulcus.
7. parieto-occipital sulcus.

Fig.(258): REPRESENTATION OF THE FIBRES COMING FROM THE RETINA IN THE VISUAL CORTEX AROUND THE CALCARINE SULCUS

1. visual area receiving fibres from the superior quadrant of the retina.
2. visual area receiving fibres from the macula.
3. end of calcarine sulcus.
4. visual area receiving fibres from the inferior quadrant of the retina.



SULCI AND GYRI OF INFERIOR SURFACE

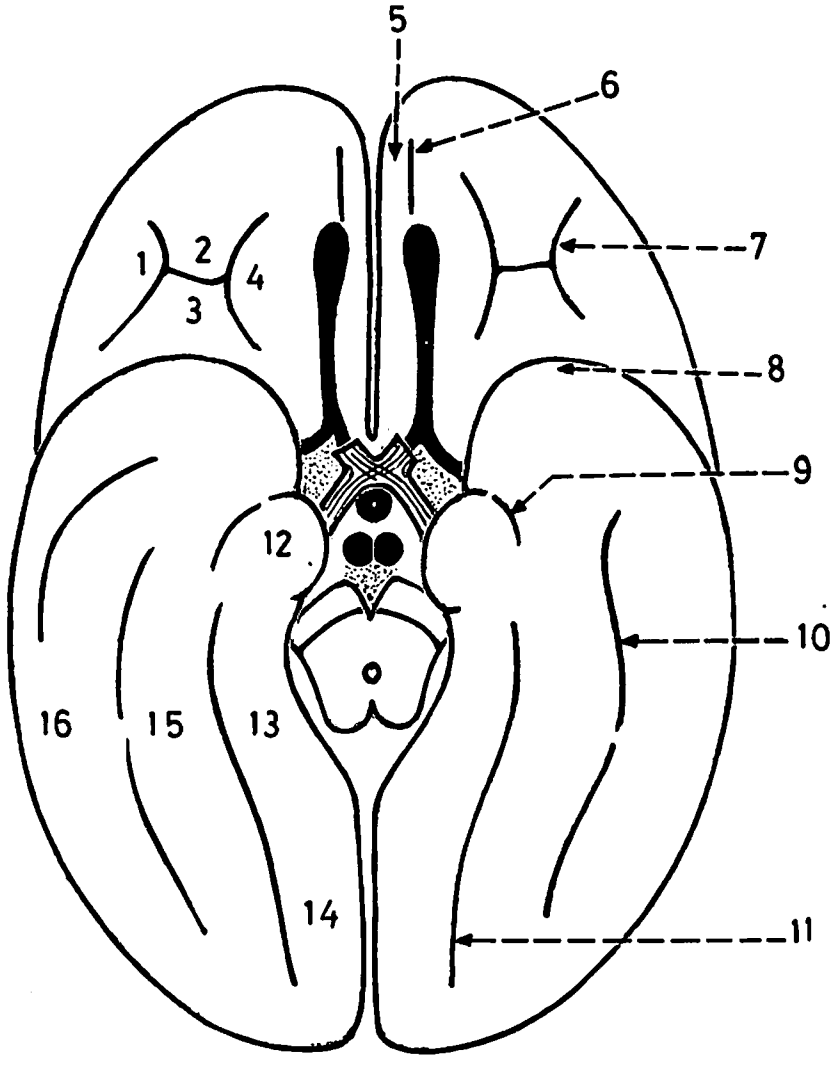


Fig.(259): SULCI AND GYRI OF INFERIOR SURFACE

1. lateral orbital gyrus.
2. anterior orbital gyrus.
3. posterior orbital gyrus.
4. medial orbital gyrus.
5. gyrus rectus (medial to the olfactory sulcus).
6. olfactory sulcus (lodges the olfactory bulb and tract).
7. orbital sulci (H-shaped).
8. temporal pole.
9. rhinal sulcus (forms the lateral limit of the uncus).
10. occipitotemporal sulcus (the lateral sulcus on the tentorial surface).
11. collateral sulcus (medial to the occipitotemporal sulcus and parallel to it).
12. uncus (anterior end of the parahippocampal gyrus).
13. parahippocampal gyrus (forms the parahippocampal border).
14. lingual gyrus (between the collateral and calcarine sulci).
15. medial occipitotemporal gyrus (between the collateral and occipitotemporal sulci).
16. lateral occipitotemporal gyrus (lateral to the occipitotemporal sulcus).

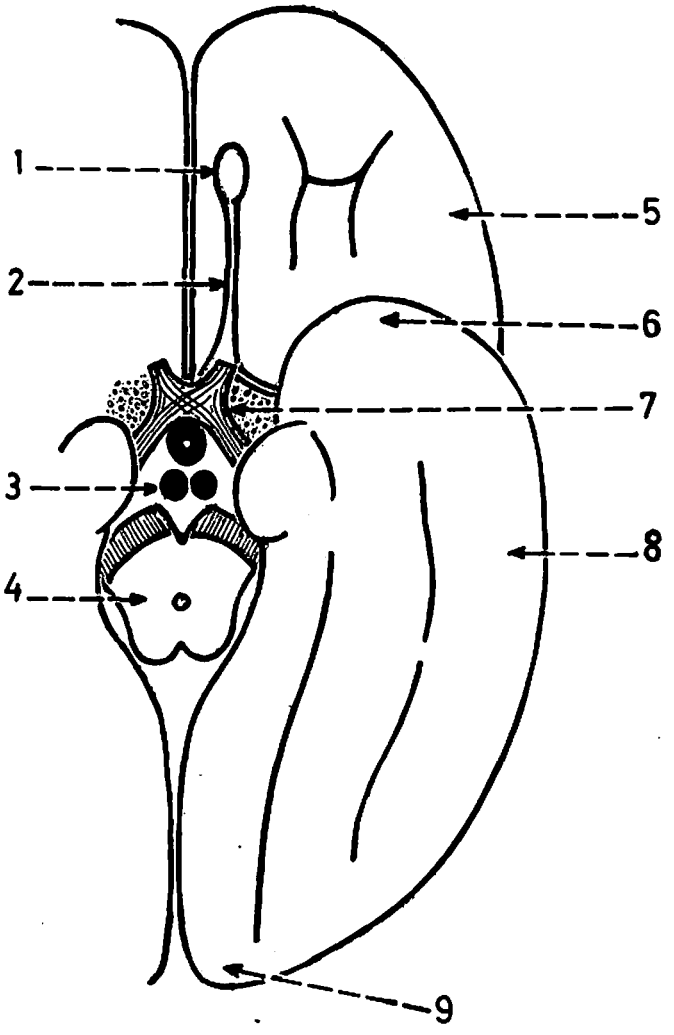


Fig.(260): STRUCTURES AT THE MIDLINE OF THE BASE OF THE BRAIN

These are the optic chiasma, interpeduncular fossa and midbrain.

1. olfactory bulb.
2. olfactory tract.
3. interpeduncular fossa (tuber cinereum, mamillary bodies and posterior perforated substance).
4. midbrain.
5. orbital part of the inferior surface.
6. temporal pole.
7. optic chiasma with the anterior perforated substance on each side.
8. tentorial surface.
9. occipital pole.

CEREBRAL CORTEX

STRUCTURE OF CEREBRAL CORTEX

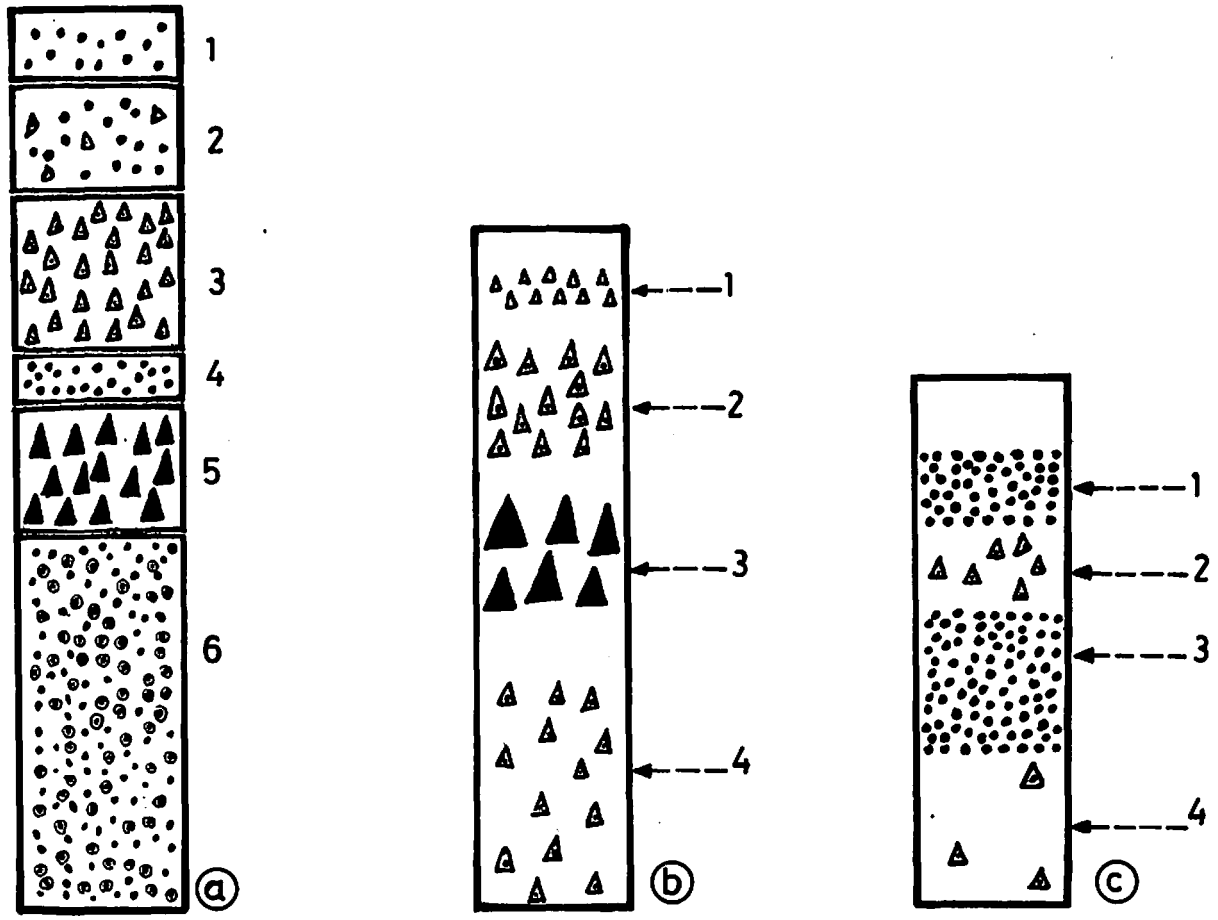


Fig.(261): LAYERS OF THE CEREBRAL CORTEX

(a) Cerebral cortex in general: it consists of 6 layers.
1. molecular layer (most superficial); 2. outer granular layer (granule cells); 3. pyramidal layer (medium-sized pyramidal cells); 4. inner granular layer (granule cells); 5. ganglionic layer (large pyramidal cells); 6. polymorphous layer (pleomorphic cells).

(b) Motor cortex: it contains no granule cells but all grades of pyramidal cells as in motor and premotor areas.
1. small pyramidal cells; 2. medium pyramidal cells; 3. large pyramidal cells (giant cells of Betz); 4. medium pyramidal cells.

(c) Sensory or granular cortex: it is rich in granule cells and is thinner than the motor cortex, as in the somatosensory area.
1. granule cells; 2. few small pyramidal cells; 3. granule cells; 4. very few pyramidal cells.

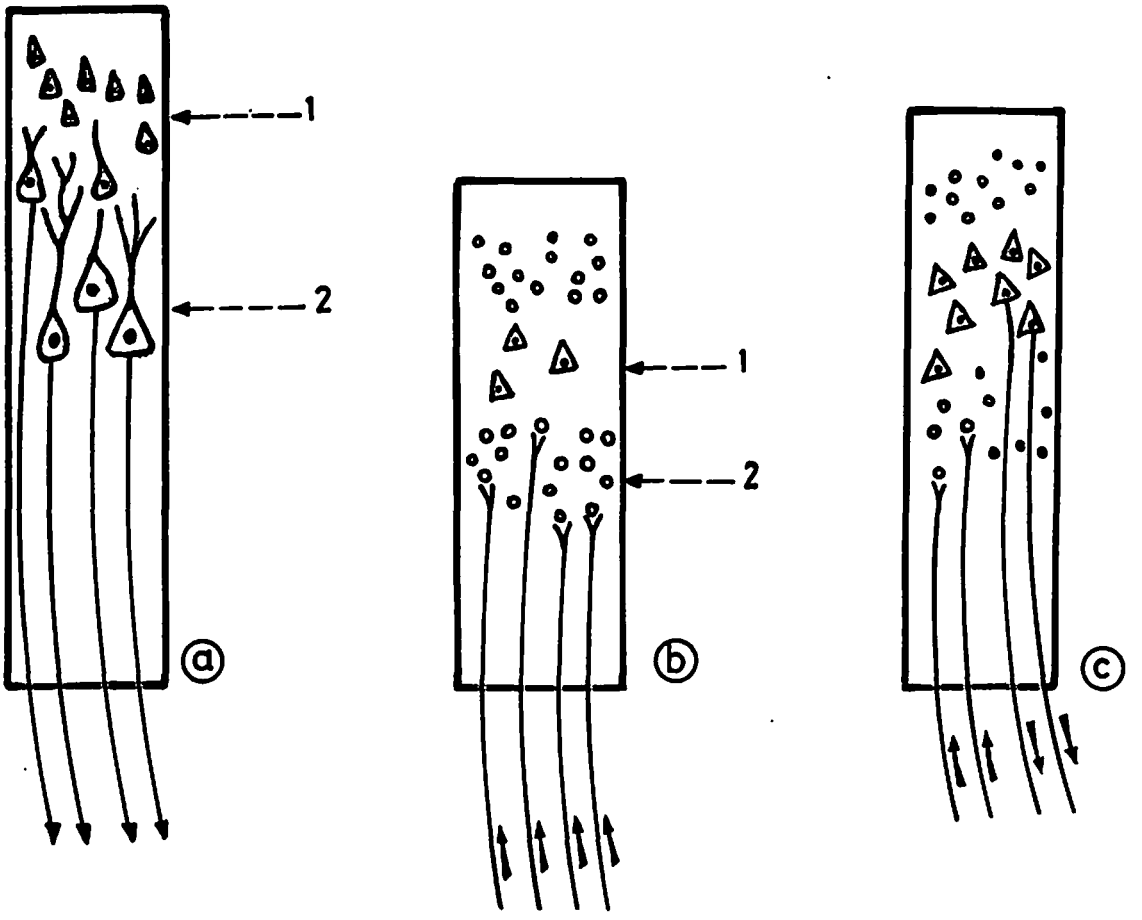


Fig.(262): FIBRES DESCENDING FROM AND ASCENDING TO THE CEREBRAL CORTEX

(a) Descending fibres: these are the pyramidal and extrapyramidal fibres which arise from the pyramidal cells and descend to the brainstem and spinal cord.
1. small and medium-sized pyramidal cells.
2. large pyramidal cells.

(b) Ascending fibres: these are the fibres carrying the somatic sensations from the body and ascend to the sensory cortex where they end on the granule cells.
1. very few pyramidal cells.
2. granule cells.

(c) Ascending and descending fibres: these fibres are connected with areas of the cortex which are intermediate in type containing both pyramidal and granule cells. The pyramidal cells give rise to the corticopontine fibres, while the granule cells in the same cortex receive ascending sensory fibres.

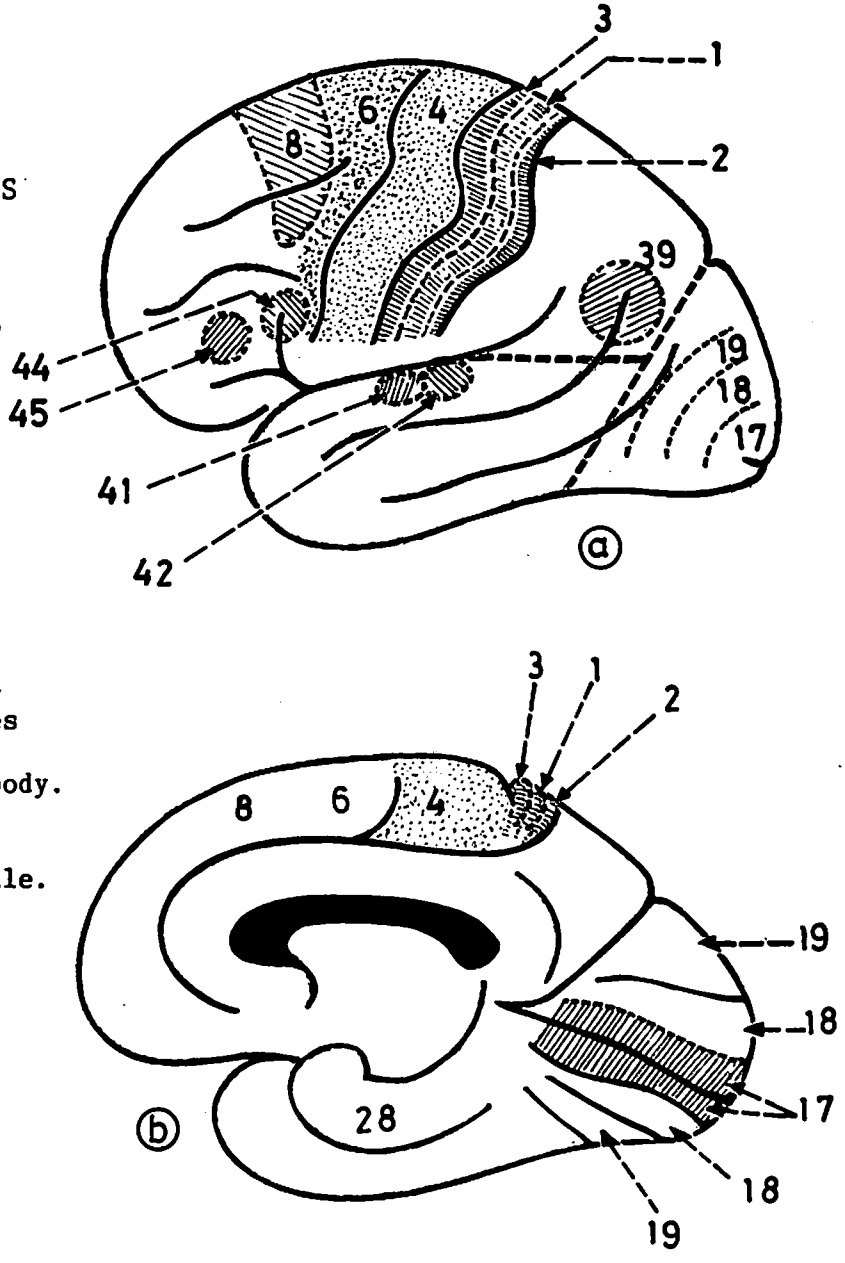
CORTICAL AREAS

Fig.(263): MAIN CORTICAL AREAS

The cerebral cortex is described by Brodmann to consist of 52 areas according to their histological structure and function.

(a) superolateral surface.

(b) medial surface.



* areas 3,1,2 : occupy the postcentral gyrus and extend on to the paracentral lobule. They constitute the 1st somatosensory area which receives general sensations from the opposite side of the body.
* area 4 : occupies the precentral gyrus and extends on to the paracentral lobule. It constitutes the motor area which gives rise to pyramidal fibres.
* area 6 : occupies the posterior parts of the frontal gyri (premotor area). It is an extrapyramidal centre.
* area 8 : this is the frontal eye field.
* areas 44, 45 : occupy the posterior part of the inferior frontal gyrus, and constitute the motor speech area of Broca.
* areas 41, 42 : occupy the middle of the superior temporal gyrus and extend deeply on the anterior transverse temporal gyrus. These areas constitute the acoustic area which receives the acoustic radiation (hearing).
* area 39 : it lies in the inferior parietal lobule and constitutes the speech area of Wernicke.
* areas 17, 18, 19 : lie in the occipital lobe occupying the lingual gyrus and cuneus. They constitute the visual area which receives the optic radiation.
* area 28 : occupies the anterior part of the parahippocampal gyrus and constitutes the olfactory area.

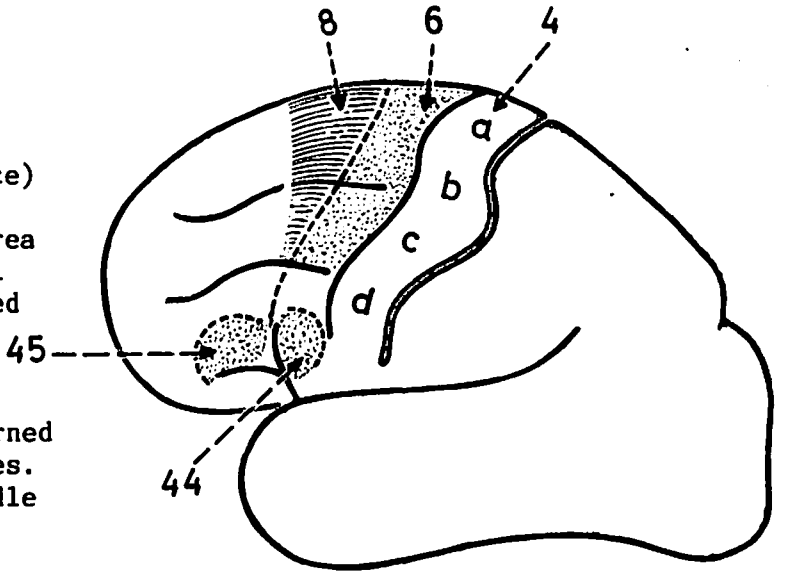


Fig.(264): CORTICAL AREAS OF FRONTAL LOBE (superolateral surface)

* area 4 : this is the motor area which occupies the precentral gyrus. The body is represented upside-down where the lower limb is the highest and the head and neck is the lowest.
* area 6 : premotor area concerned with extrapyramidal activities.
* area 8 : its part in the middle frontal gyrus is called the frontal eye field.
* areas 44, 45 : motor speech area (Broca's area).

a. motor area for lower limb.
b. motor area for trunk.
c. motor area for upper limb.
d. motor area for head and neck.

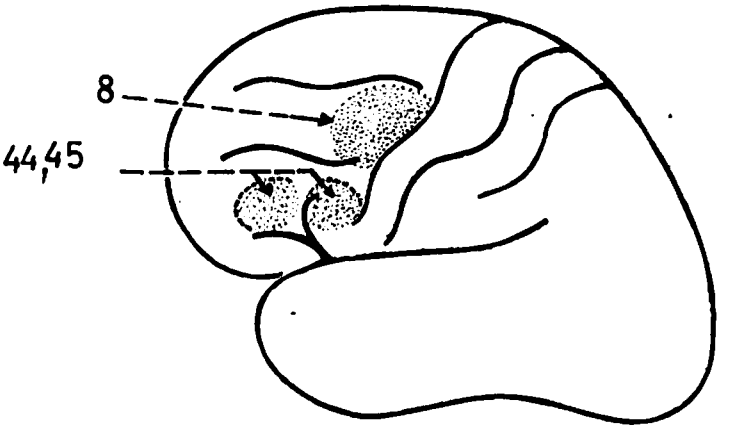


Fig.(265): FRONTAL EYE FIELD AND BROCA'S AREA

* frontal eye field (area 8): lies in the posterior part of the middle frontal gyrus. Its stimulation leads to conjugate eye movements to the opposite side.
* Broca's area (areas 44, 45): lies in the posterior part of the inferior frontal gyrus. Its damage on the left side leads to motor aphasia.

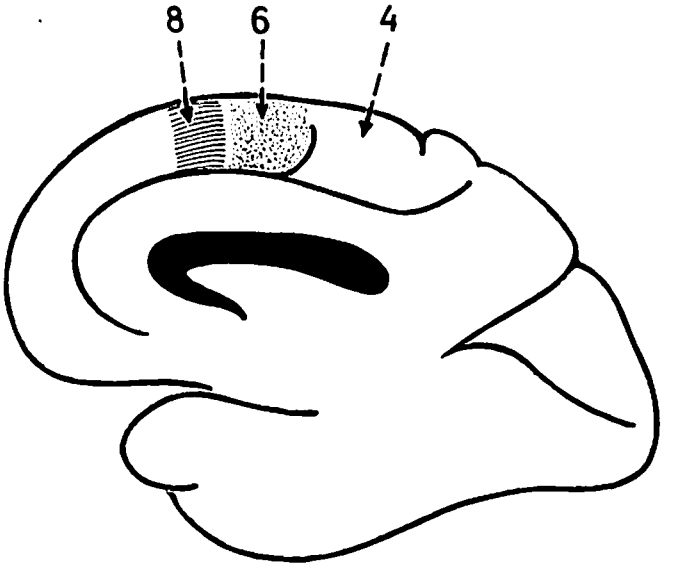


Fig.(266): EXTENSIONS OF AREAS 4, 6, 8 ON THE MEDIAL SURFACE

* area 4 : lies in the paracentral lobule and is the motor area for the foot and perineum.
* area 6 : premotor area (extra-pyramidal).

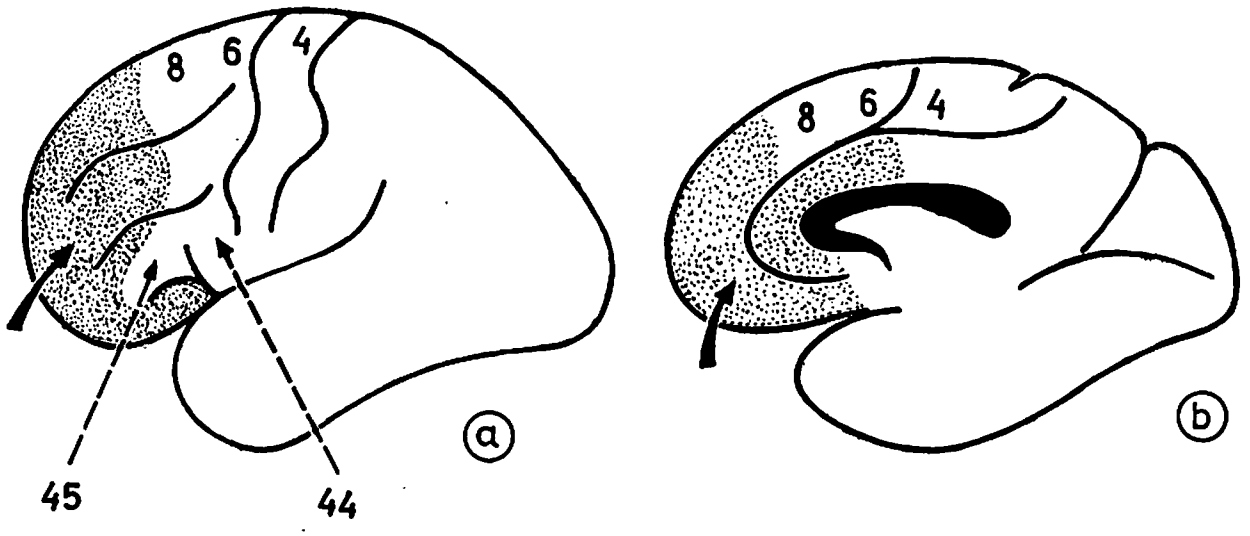


Fig.(267): PREFRONTAL AREA

This is the most anterior part of the frontal lobe and lodges the silent areas.

(a) prefrontal area on the superolateral surface (arrow).

(b) prefrontal area on the medial surface (arrow).

Fig.(268): CONNECTIONS OF THE PREFRONTAL AREA

This area receives afferent fibres from the hypothalamus through the anterior and medial nuclei of the thalamus.

1. hypothalamic nuclei.
2. anterior and medial nuclei of the thalamus.
3. thalamocortical fibres to the prefrontal area.

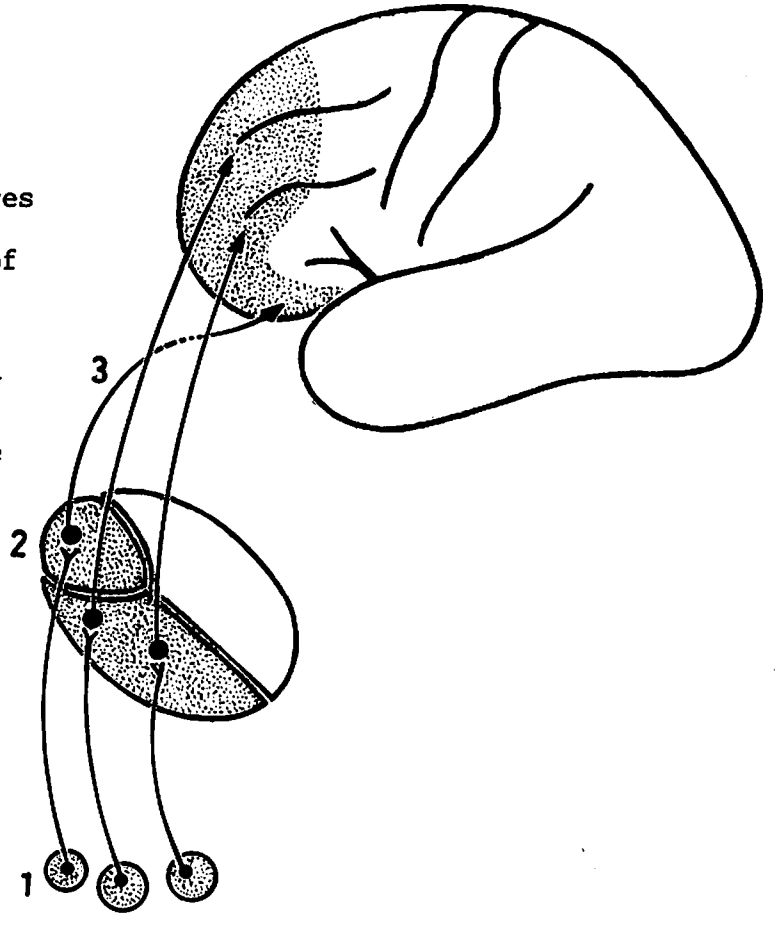


Fig.(269): CORTICAL AREAS OF PARIETAL LOBE (superolateral surface)

* areas 3, 1, 2 : they occupy the postcentral gyrus (somatosensory area). The body is represented upside-down.
* areas 39, 40 : 2nd speech area of Wernicke.

a. sensory area for lower limb.
b. sensory area for trunk.
c. sensory area for upper limb.
d. sensory area for head and neck.

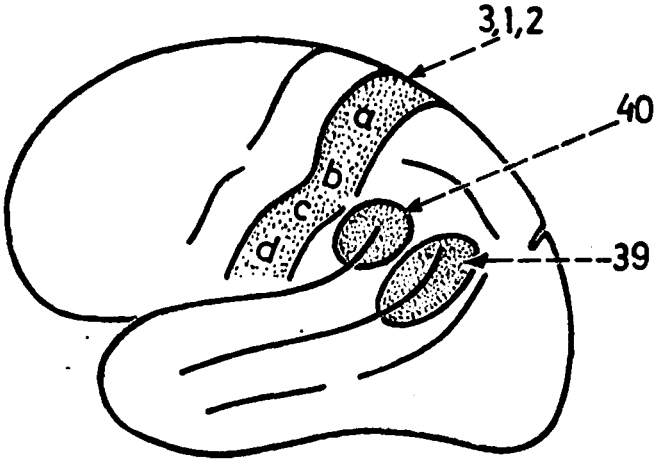


Fig.(270): CONNECTIONS OF THE SOMATOSENSORY AREA

The somatosensory area (3, 1, 2) receives afferent fibres from the posterior ventral nucleus of the thalamus carrying somatic sensations from the opposite 1/2 of the body.

1. posterior ventral nucleus of thalamus.
2. thalamocortical fibres (superior thalamic radiation).
3. somatosensory area (3, 1, 2).

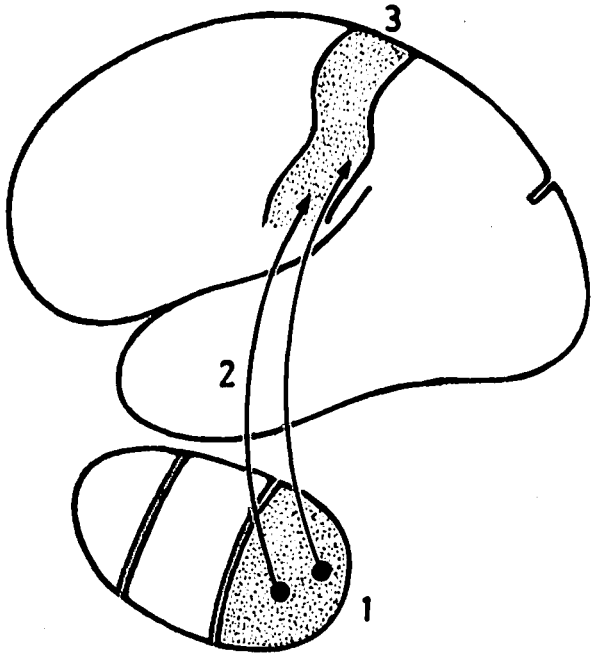
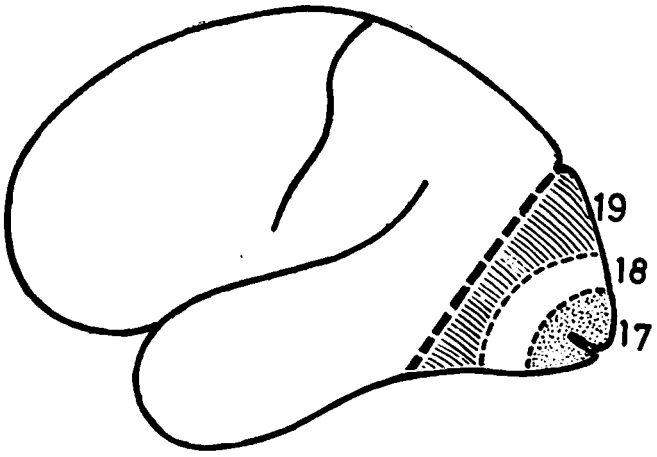


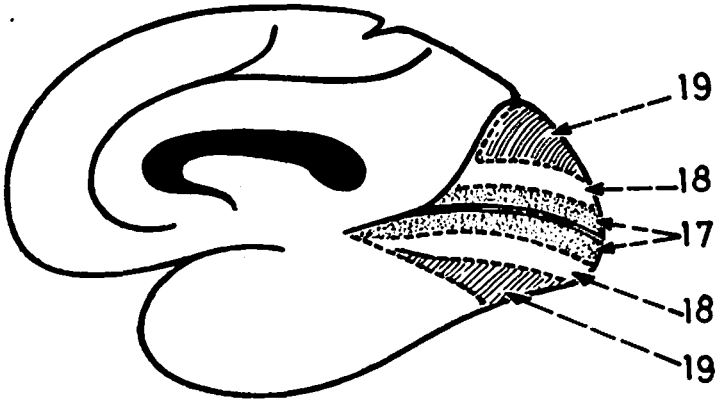
Fig.(271): CORTICAL AREAS OF OCCIPITAL LOBE (superolateral surface)



These areas are concerned with vision.

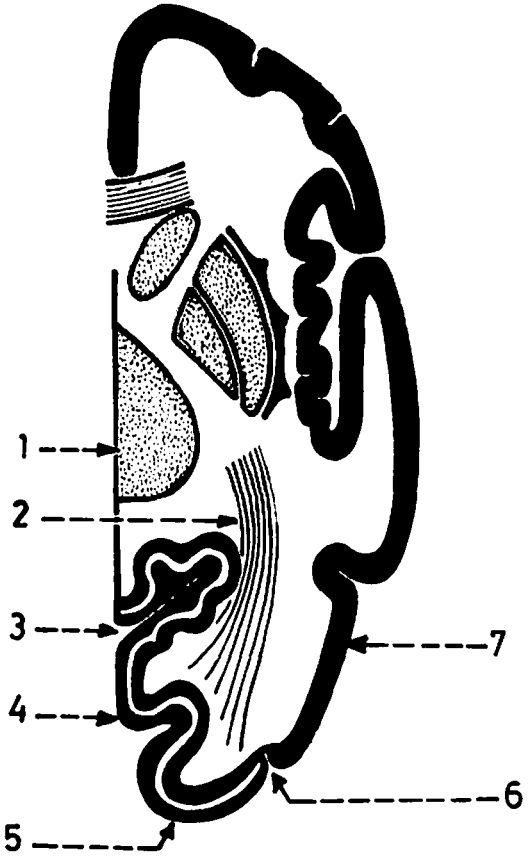
* area 17 : striate cortex.
* area 18 : parastriate cortex.
* area 19 : peristriate cortex.

Fig.(272): CORTICAL AREAS OF OCCIPITAL LOBE (medial surface)



* area 17 : in the upper and lower lips as well as in the depth of the posterior part of calcarine sulcus. It is limited on the lateral surface by the lunate sulcus.
* area 18 : above and below area 17.
* area 19 : most peripheral.

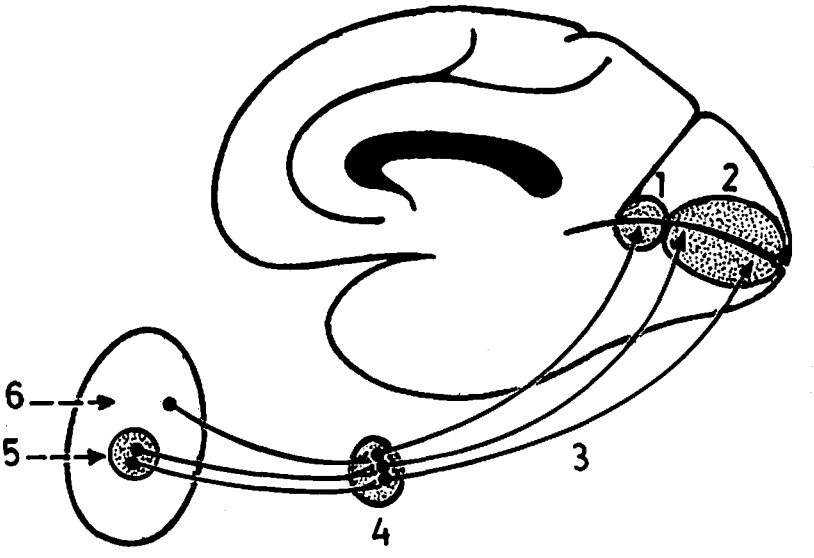
Fig. (273): STRIATE CORTEX (horizontal section in the cerebral hemisphere)



The striate cortex differs from the rest of the cerebral cortex in having a white band within the grey matter.

1. thalamus.
2. optic radiation.
3. calcarine sulcus (its lips and depth are formed by striate cortex).
4. striate cortex.
5. occipital pole.
6. lunate sulcus.
7. non-striate cortex.

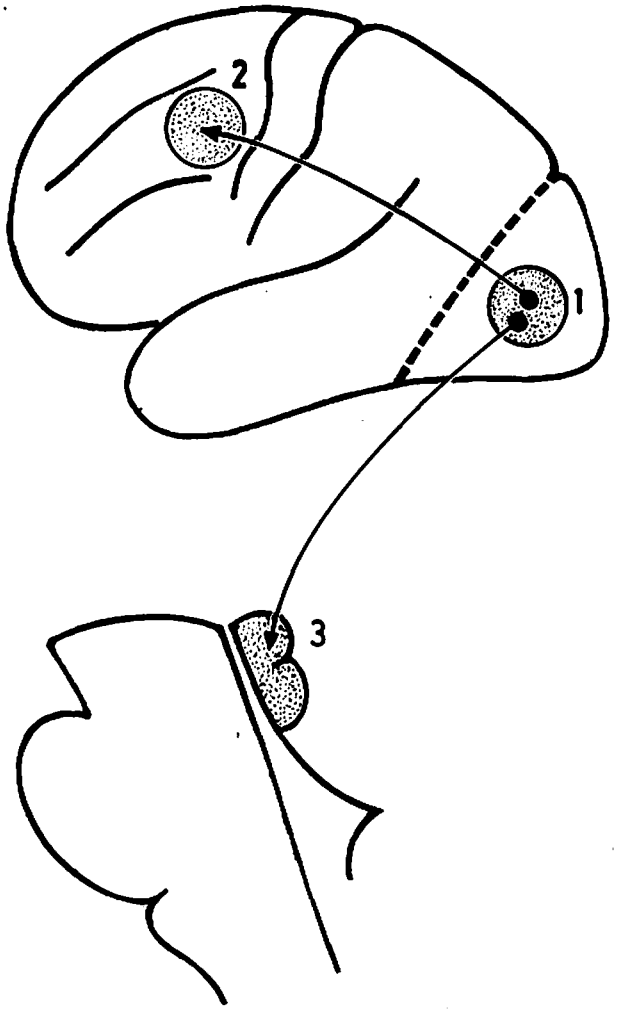
Fig.(274): REPRESENTATION OF THE RETINA IN THE STRIATE CORTEX



The macula of the retina is represented in the striate cortex by a larger area than the peripheral part of the retina.

1. area of striate cortex receiving fibres from the peripheral part of the retina.
2. area of striate cortex receiving fibres from the macula.
3. optic radiation.
4. lateral geniculate body.
5. macula.
6. peripheral part of the retina.

Fig.(275): EFFERENT FIBRES FROM THE OCCIPITAL CORTEX



The occipital eye field in area 18 sends efferent fibres to the frontal eye field in area 8, as well as to the superior colliculus of the midbrain.

1. occipital eye field.
2. frontal eye field.
3. superior colliculus.

* stimulation of the occipital eye field results in conjugate movements of the eye and turning of the head to the opposite side.

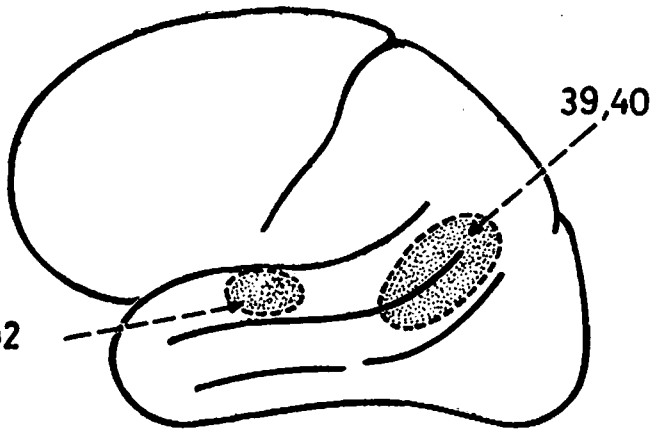


Fig.(276): CORTICAL AREAS OF THE TEMPORAL LOBE (superolateral surface)

The temporal cortex contains the auditory area (areas 41, 42), in addition to the speech area of Wernicke (areas 39, 40) which extends into the temporal lobe.

* areas 41, 42 : form the auditory area which lies in the middle of the superior temporal gyrus and extends into the transverse temporal gyrus siutated in the lower lip of the posterior ramus of lateral sulcus.

* areas 39, 40 : form the speech area of Wernicke which lies partly in the parietal lobe and partly in the temporal lobe.

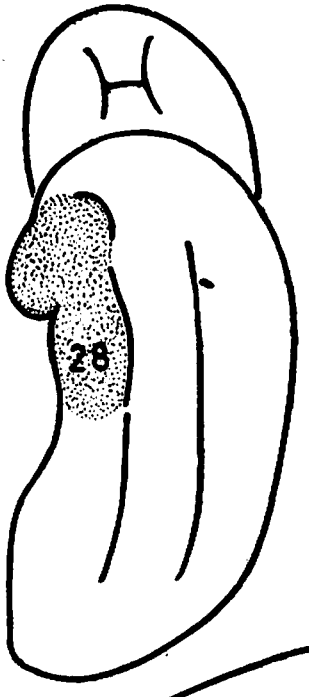


Fig.(277): CORTICAL AREAS OF THE TEMPORAL LOBE (inferior surface)

The inferior surface of the temporal lobe contains the olfactory area which is confined to the uncus and anterior part of the parahippocampal gyrus (area 28).

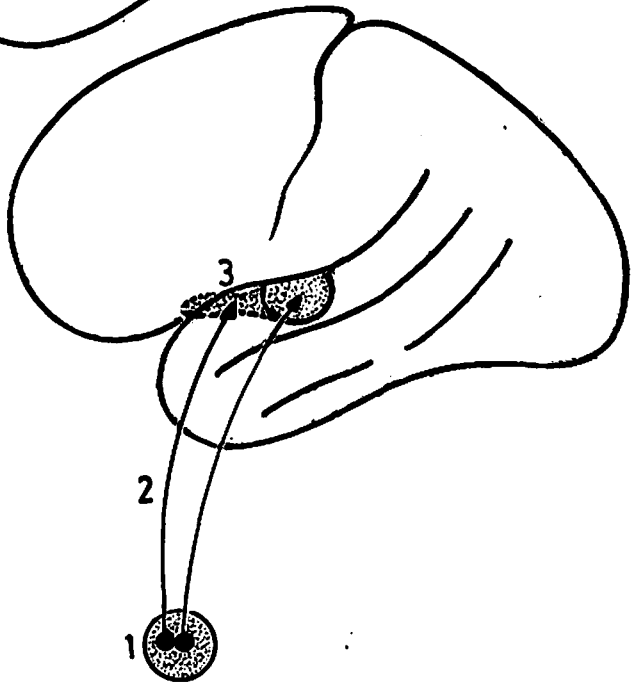


Fig.(278): AUDITORY RADIATION

The auditory area in the temporal lobe receives fibres of auditory radiation from the medial geniculate body.

1. medial geniculate body.
2. auditory radiation.
3. auditory area (41, 42).

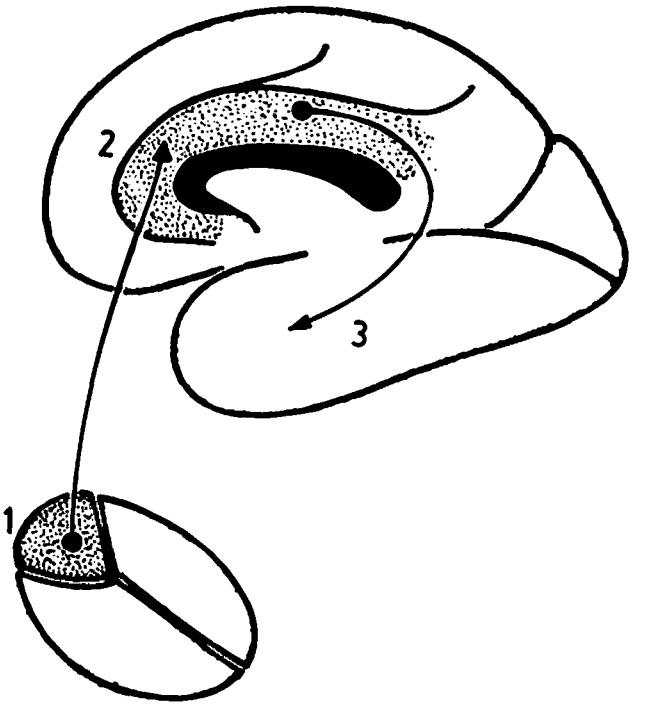


Fig.(279): CONNECTIONS OF CINGULATE GYRUS

The cingulate gyrus is a part of the limbic system. It receives afferent fibres from the anterior nucleus of the thalamus, and sends efferent fibres to the hippocampus.

1. anterior nucleus of thalamus.
2. cingulate gyrus.
3. efferent fibres to the hippocampus.

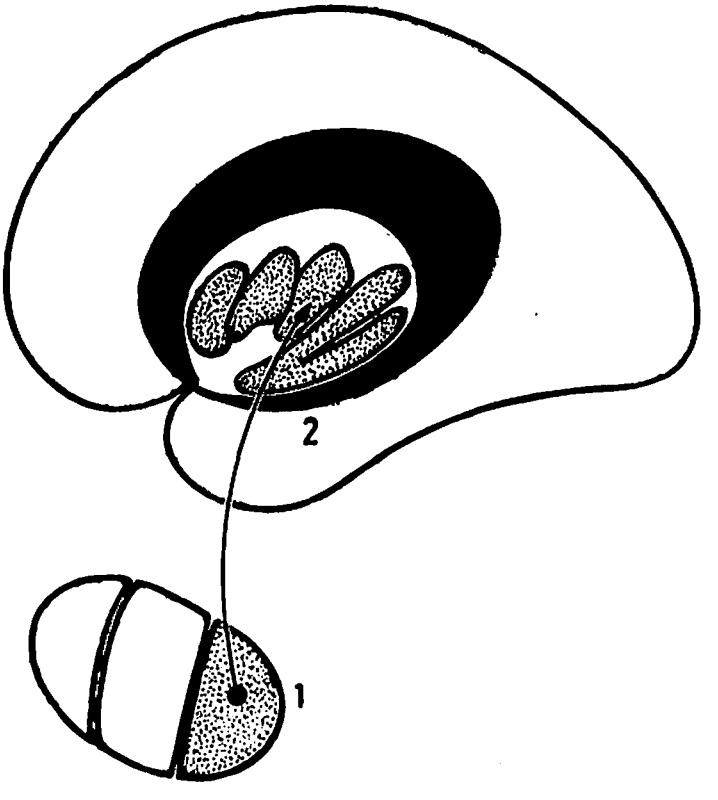


Fig.(280): CORTICAL AREA FOR TASTE

It is believed that the insula contains the area for taste. This gustatory area receives afferents from the posteromedial ventral nucleus of thalamus.

1. posteromedial ventral nucleus of thalamus.
2. insula.

LIMBIC SYSTEM

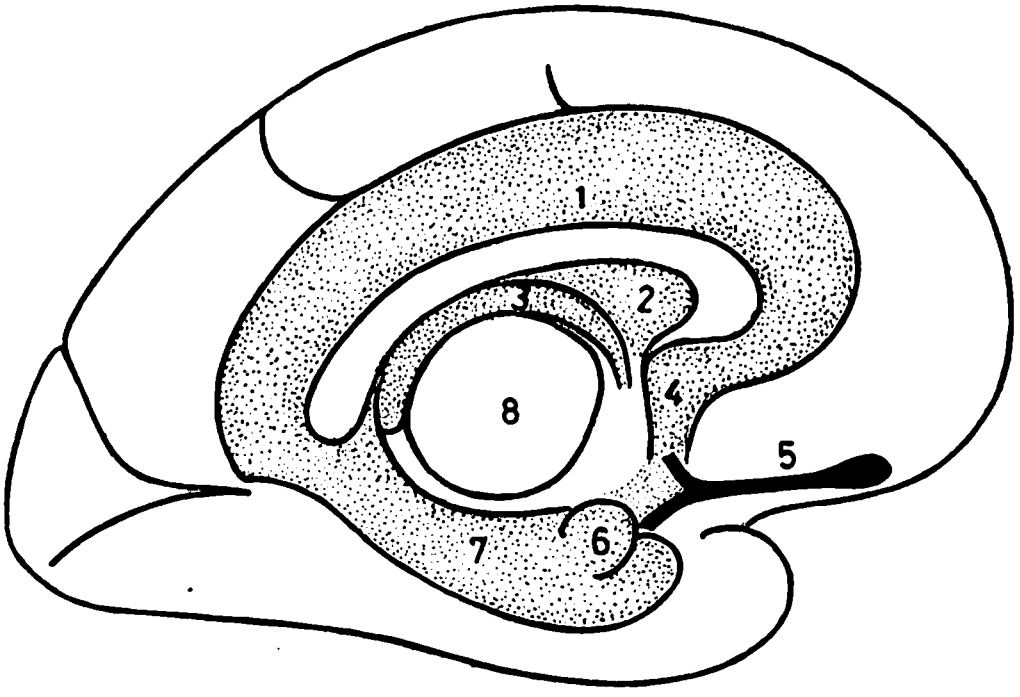


Fig.(281): COMPONENTS OF THE LIMBIC SYSTEM

The limbic system (limbic lobe) is an arched region bordering the thalamus. Its components are both olfactory and non-olfactory in function. The olfactory components form the rhinencephalon (olfactory bulb, olfactory tract, olfactory trigone, anterior perforated substance, uncus and anterior part of the parahippocampal gyrus). The other components are the amygdaloid body, septum pellucidum, hippocampal formation, fornix, stria terminalis, stria habenularis and 2 gyri (cingulate gyrus and parahippocampal gyrus).

1. cingulate gyrus.
2. septum pellucidum.
3. fornix.
4. paraterminal gyrus.
5. olfactory bulb and tract.
6. uncus.
7. parahippocampal gyrus.
8. thalamus.

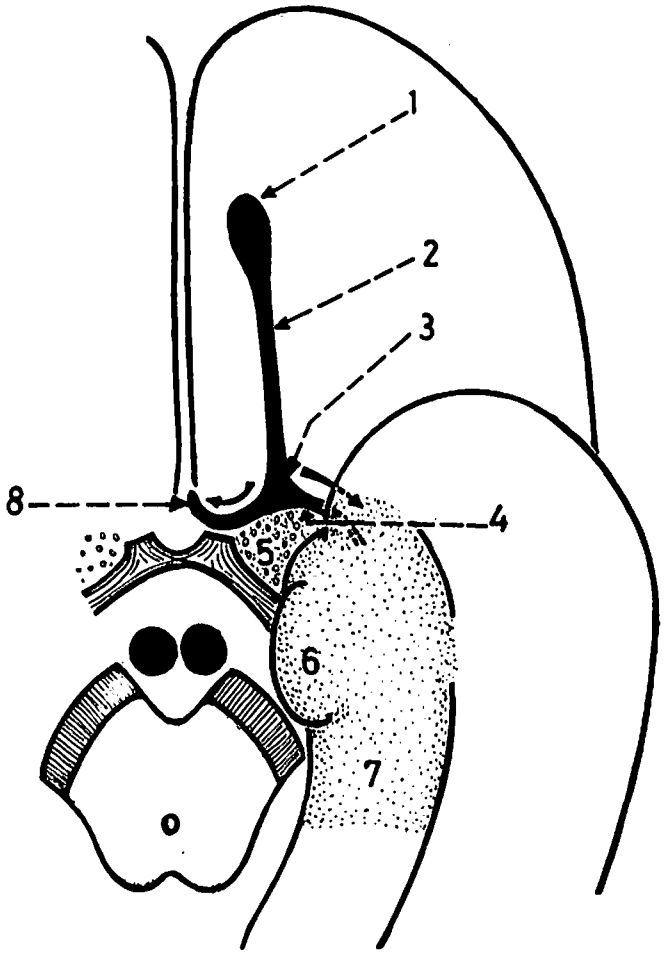


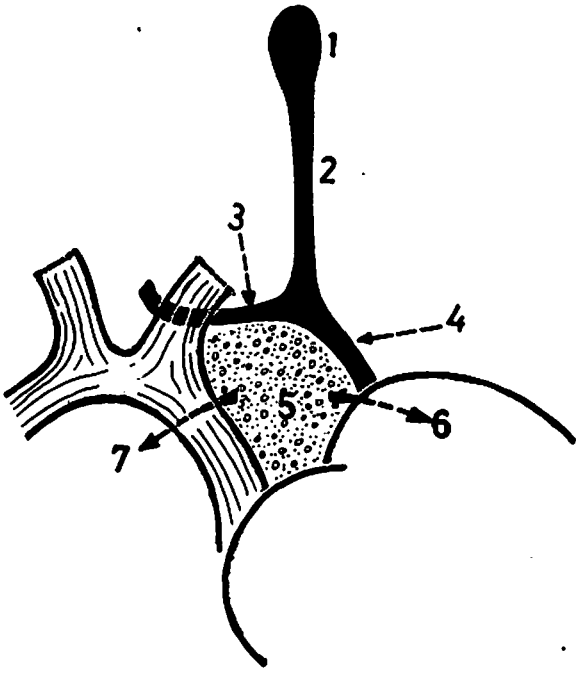
Fig.(282): RHINENCEPHALON

It is a component of the limbic system concerned with olfaction (sense of smell). It consists of the olfactory bulb, olfactory tract, olfactory trigone, olfactory striae, anterior perforated substance, uncus and anterior part of parahippocampal gyrus. The uncus and anterior part of parahippocampal gyrus form together the piriform cortex.

1. olfactory bulb (collection of nerve cells).
2. olfactory tract (2nd order neurons).
3. olfactory trigone (triangular area at the end of the olfactory tract).
4. lateral olfactory stria (runs along the lateral margin of the anterior perforated substance to end in the uncus).
5. anterior perforated substance (perforated area of grey matter).
6. uncus (terminal end of the parahippocampal gyrus).
7. anterior part of parahippocampal gyrus (area 28).
8. medial olfactory stria (runs medially in front of the anterior perforated substance to end in the paraterminal gyrus).

* The uncus and anterior part of parahippocampal gyrus form the cortical centre for smell.

Fig.(283): ANTERIOR PERFORATED SUBSTANCE

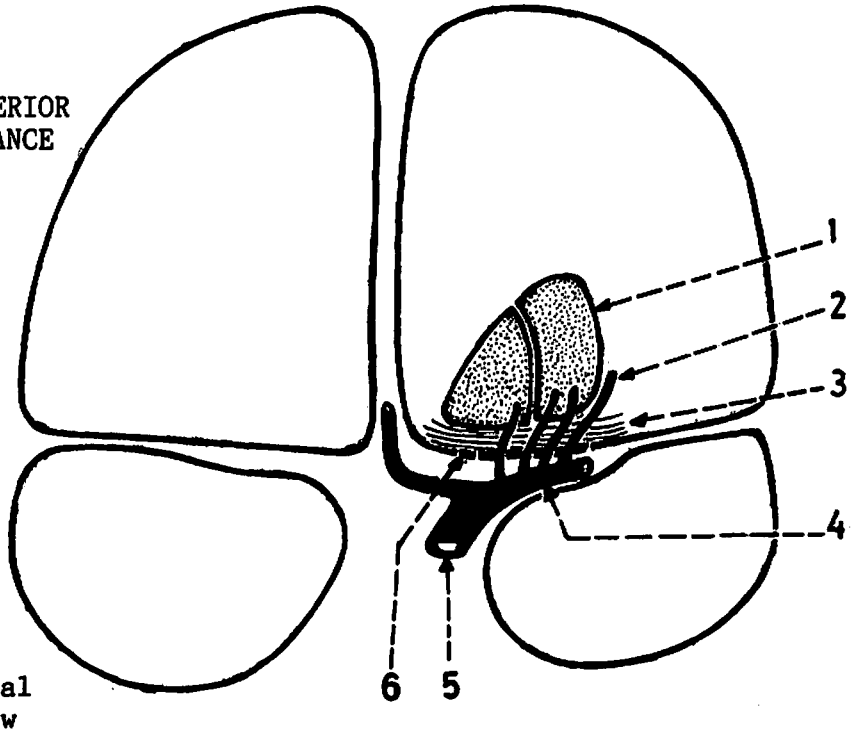


It is a perforated area of grey matter at the base of the brain situated on each side of the optic chiasma. It is continuous medially with the tuber cinereum and laterally with the limen insulae (apex of the insula). It is bounded in front and laterally by the 2 olfactory striae.

1. olfactory bulb.
2. olfactory tract.
3. medial olfactory stria.
4. lateral olfactory stria.
5. anterior perforated substance.
6. the anterior perforated substance is continuous laterally with the limen insulae.
7. the anterior perforated substance is continuous medially with the tuber cinereum.

* The anterior perforated substance is a part of the rhinencephalon.

Fig.(284): RELATIONS OF ANTERIOR PERFORATED SUBSTANCE



The anterior perforated substance is related above to the corpus striatum from which it is separated by the anterior commissure, and below to the end of the internal carotid artery.

1. lentiform nucleus.
2. central arteries.
3. anterior commissure.
4. middle cerebral artery in the stem of the lateral sulcus.
5. termination of the internal carotid artery (just below the anterior perforated substance).
6. anterior perforated substance (perforated by the central arteries).

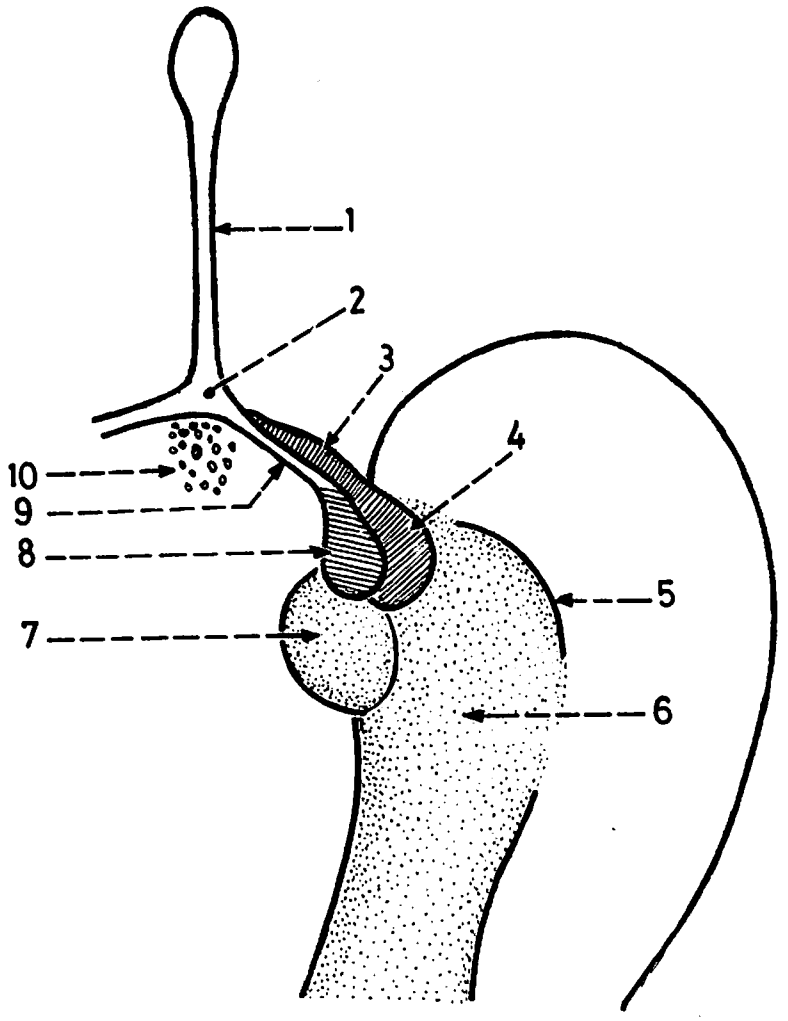


Fig.(285): OLFACTORY CORTEX

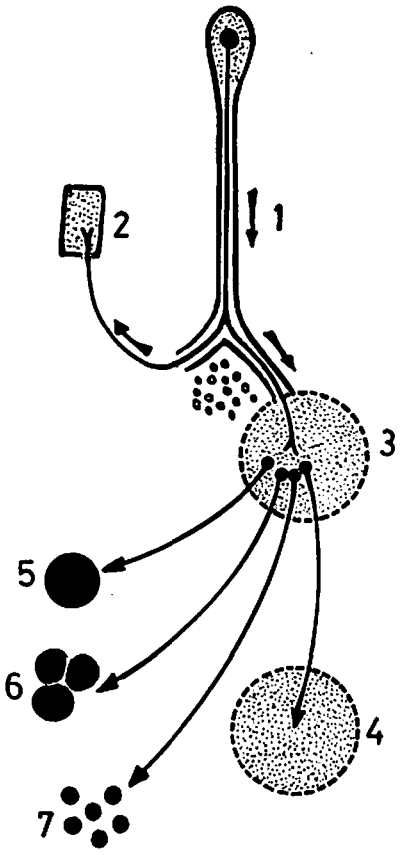
The olfactory cortex consists of the uncus, anterior part of the parahippocampal gyrus (area 28) and anterior perforated substance. These areas form what is called piriform cortex and are responsible for the appreciation of the sense of smell.

1. olfactory tract.
2. olfactory trigone.
3. grey matter over the lateral olfactory stria.
4. grey matter of the limen insulae (gyrus ambiens).
5. rhinal sulcus.
6. area 28 (anterior part of parahippocampal gyrus).
7. uncus.
8. grey matter overlying the amygdaloid body.
9. lateral olfactory stria.
10. anterior perforated substance.

Fig.(286): OLFACTORY PATHWAYS

The fibres of the olfactory tract (2nd order neurons) divide into medial and lateral olfactory striae. The fibres of the medial olfactory stria end in the paraterminal gyrus, and from there they eventually reach the hippocampus. The fibres of the lateral olfactory stria end in the anterior perforated substance and the uncus,and from there the fibres eventually end in area 28 (anterior part of parahippocampal gyrus), amygdaloid nucleus and hypothalamic nuclei.

1. olfactory tract.
2. paraterminal gyrus.
3. uncus and anterior perforated substance.
4. anterior part of parahippocampal gyrus or area 28 (for cortical appreciation of smell).
5. amygdaloid nucleus (for olfactory reflexes).
6. hypothalamic nuclei (for olfactory reflexes).
7. septal nuclei (in septum pellucidum).



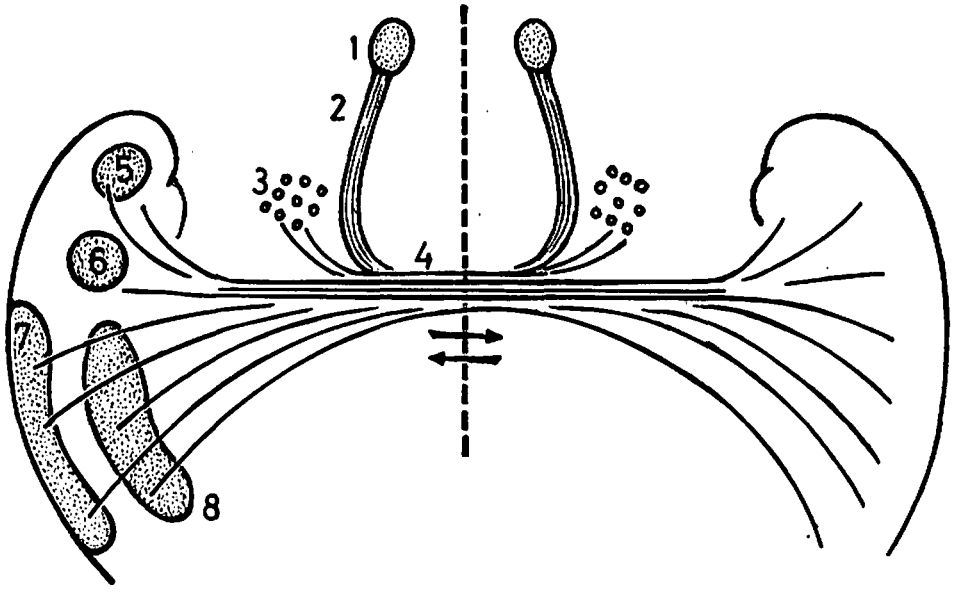
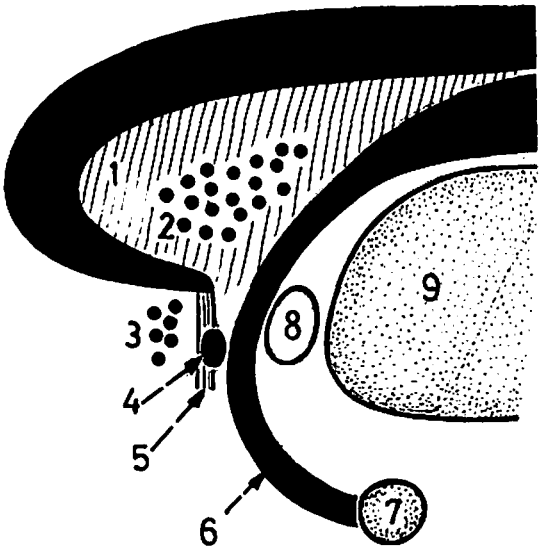


Fig.(287):ANTERIOR COMMISSURE

It consists of commissural fibres which connect mainly olfactory centres in one temporal lobe with those in the opposite lobe.

1. olfactory bulb.
2. olfactory tract.
3. anterior perforated substance.
4. anterior commissure.
5. uncus.
6. amygdaloid nucleus.
7. middle and inferior temporal gyri.
8. paraterminal gyrus.

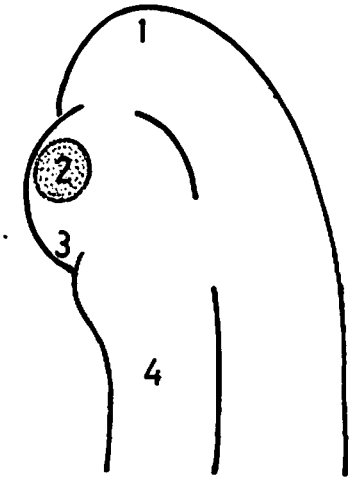
Fig.(288): SEPTAL NUCLEI



These nuclei form a part of the limbic system and are connected with the hippocampus as well as with hypothalamic nuclei. They lie partly above the anterior commissure and partly in front of it.

1. septum pellucidum.
2. septal nuclei above the anterior commissure.
3. septal nuclei in front of the anterior commissure.
4. anterior commissure.
5. lamina terminalis.
6. column of the fornix.
7. mamillary body.
8. interventricular foramen.
9. thalamus.

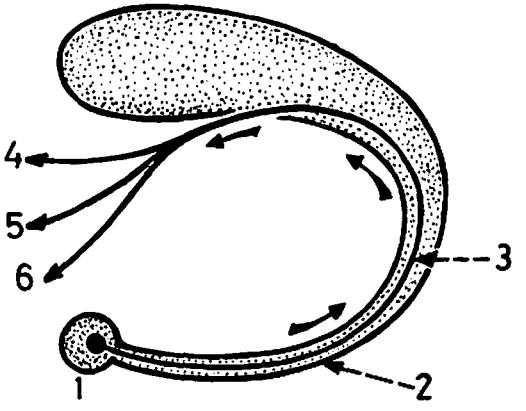
Fig.(289): POSITION OF THE AMYGDALOID BODY



The amygdaloid body or amygdala consists of 2 nuclei which lie in the medial part of the temporal pole just in front of the uncus.

1. temporal pole.
2. amygdaloid body.
3. uncus.
4. parahippocampal gyrus.

Fig.(290): CONNECTIONS OF THE AMYGDALOID BODY



The efferent fibres from the amygdaloid nucleus collect in the form of a band called stria terminalis which runs along the medial side of the tail and body of the caudate nucleus. It ends at the interventricular foramen by relaying in the anterior perforating substance, hypothalamic nuclei and habenular nucleus.

1. amygdaloid nucleus.
2. tail of caudate nucleus.
3. stria terminalis.
4. fibres to anterior perforated substance.
5. fibres to hypothalamic nuclei.
6. fibres to the habenular nucleus.

Fig.(291): HIPPOCAMPAL FORMATION

It forms an arched band which curves over the corpus callosum and continues forwards into the inferior horn of the lateral ventricle. It consists of the indusium griseum and its longitudinal striae, gyrus fasciolaris, dentate gyrus and hippocampus.

1. paraterminal gyrus.
2. indusium griseum.
3. gyrus fasciolaris.
4. dentate gyrus.
5. hippocampus (the largest part).

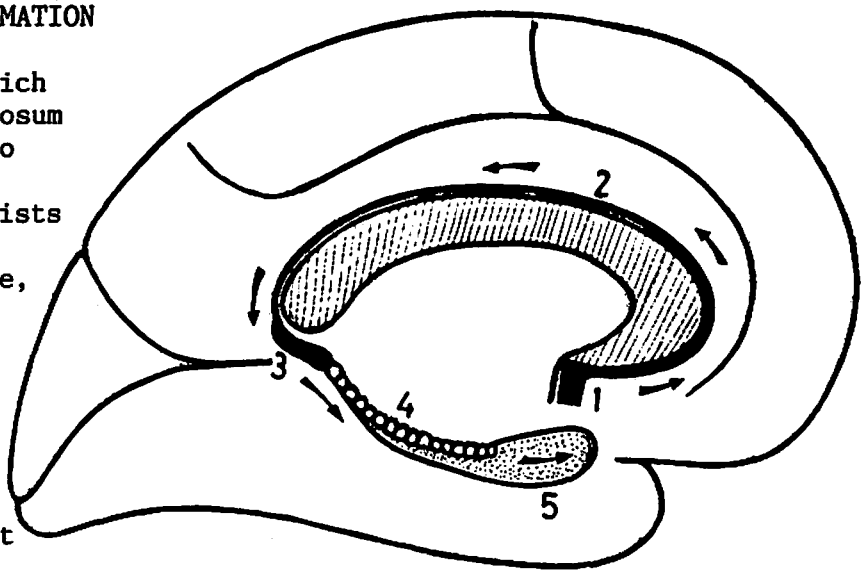


Fig.(292): INDUSIUM GRISEUM
(coronal section)

It is a thin layer of grey matter which covers the superior surface of corpus callosum. It is continuous in front with the paraterminal gyrus and behind with the gyrus fasciolaris (see fig.291). Embedded in its substance are 2 bands of white matter on each side called medial and lateral longitudinal striae.

1. lateral longitudinal stria.
2. medial longitudinal stria.
3. grey matter of the indusium griseum.
4. cingulate gyrus.
5. callosal sulcus.
6. corpus callosum.

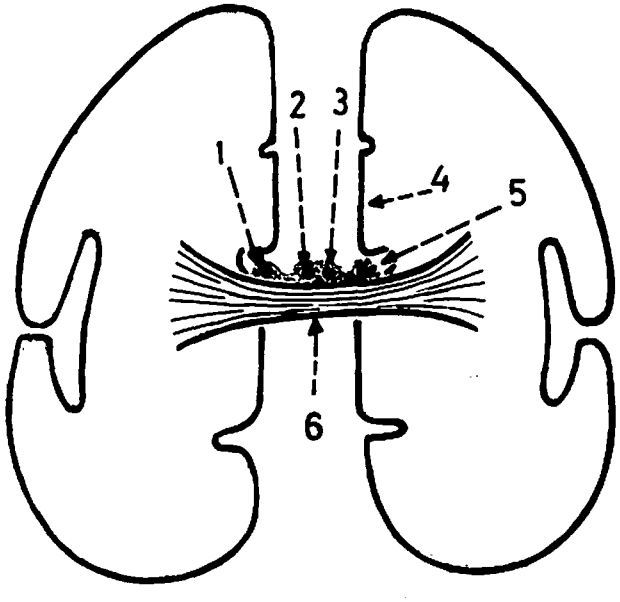
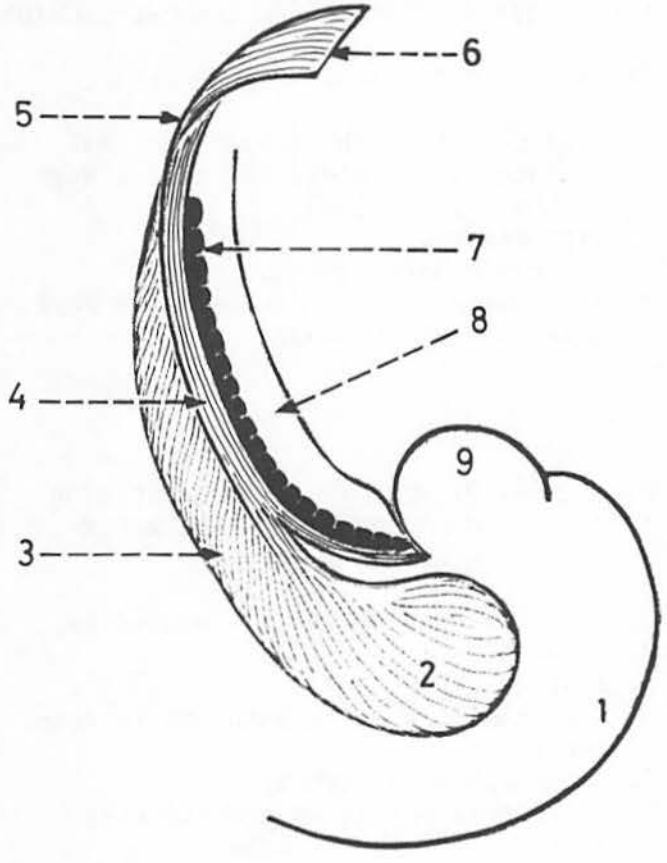


Fig.(293): HIPPOCAMPUS AND DENTATE GYRUS



The hippocampus and dentate gyrus are parts of the limbic system. The hippocampus forms an elevation 5 cm long in the floor of the inferior horn of lateral ventricle. Its anterior end is expanded and is called pes hippocampi.
The dentate gyrus is a crenated strip of grey matter placed on the medial edge of the hippocampus under cover of the fimbria. It is continuous posteriorly with the gyrus fasciolaris.

1. temporal pole.
2. pes hippocampi (anterior swollen end of hippocampus).
3. hippocampus.
4. fimbria (band of efferent fibres from the hippocampus).
5. crus of the fornix.
6. body of the fornix.
7. dentate gyrus.
8. parahippocampal gyrus.
9. uncus.

Fig.(294): PES HIPPOCAMPI

It is the swollen anterior end of the hippocampus. Its surface shows a number of ridges and furrows, and is covered by a layer of white matter called alveus.

Fig.(295): HIPPOCAMPUS IN CORONAL SECTION

It has the outline of a sea-horse.

1. fimbria (above the dentate gyrus).
2. dentate gyrus (above the medial edge of the hippocampus).
3. hippocampus.
4. parahippocampal gyrus.
5. hippocampal sulcus (between the dentate gyrus and hippocampus).

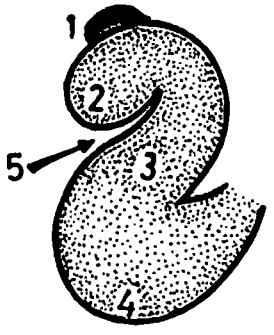


Fig.(296): HIPPOCAMPUS IN THE INFERIOR HORN OF LATERAL VENTRICLE (coronal section)

1. inferior horn of lateral ventricle.
2. fimbria.
3. dentate gyrus.
4. hippocampus bulging into the inferior horn.
5. parahippocampal gyrus.
6. collateral sulcus on the inferior surface of temporal lobe.

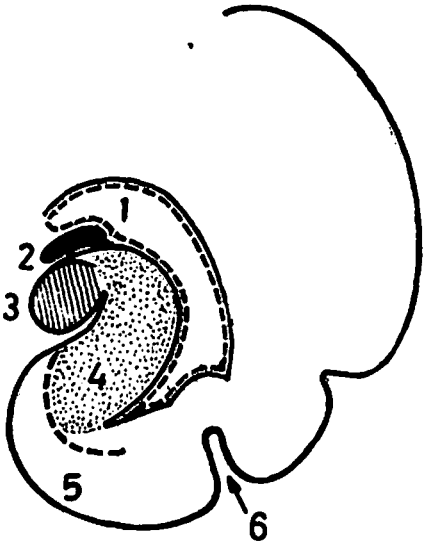
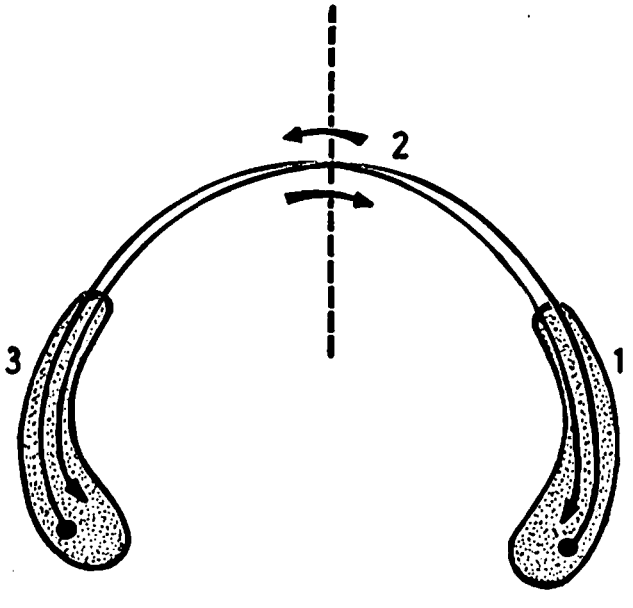


Fig.(297): HIPPOCAMPAL COMMISSURE (commissure of the fornix)

These are commissural fibres which connect the hippocampus of one side with that of the opposite side. It lies below the splenium of corpus callosum.

1. left hippocampus.
2. hippocampal commissure.
3. right hippocampus.



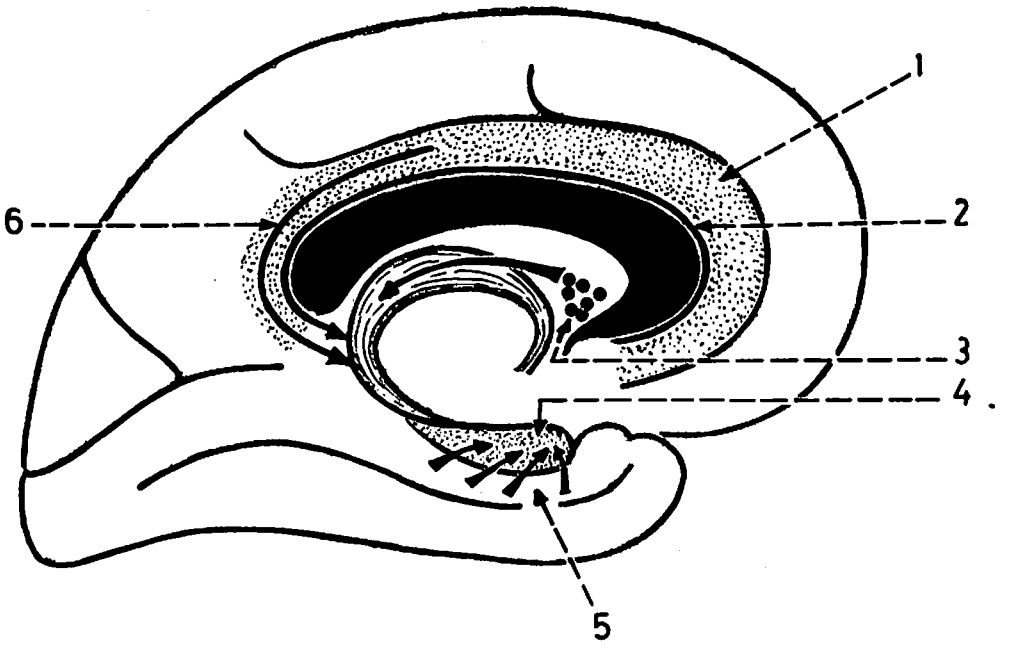


Fig.(298): AFFERENT FIBRES TO THE HIPPOCAMPUS

The hippocampus receives afferent fibres from the piriform cortex (olfactory area), cingulate gyrus, septal nuclei and indusium griseum.

1. cingulate gyrus.
2. indusium griseum.
3. septal nuclei.
4. hippocampus.
5. piriform cortex.
6. fibres from the cingulate gyrus.

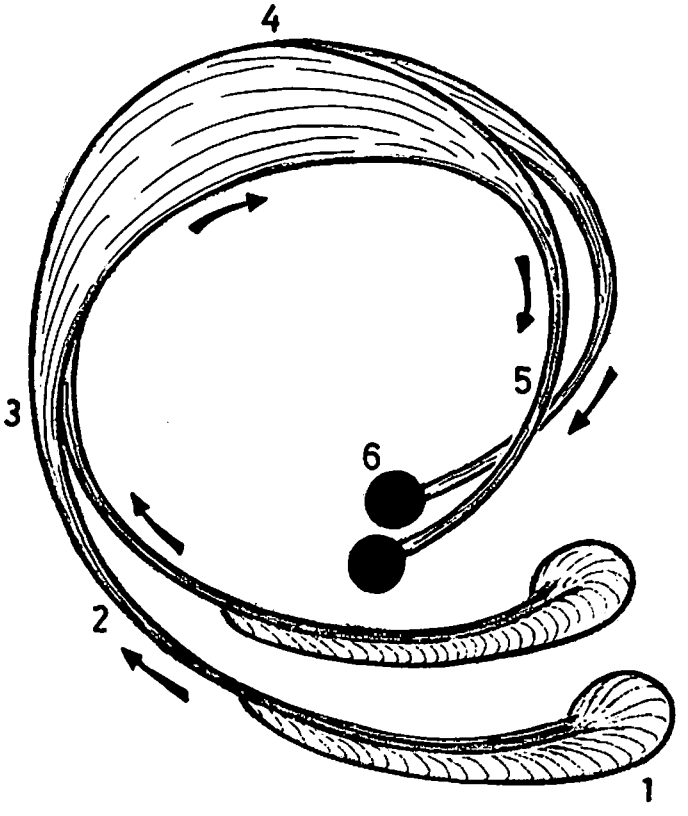


Fig.(299): FORNIX

It is a bilateral structure formed of association fibres which arise in the hippocampus and end in the mamillary body of the same side. It consists of a body, 2 crura and 2 columns.

1. hippocampus.
2. fimbria (a band of efferent fibres from the hippocampus).
3. crus of the fornix.
4. body of the fornix.
5. column of the fornix.
6. mamillary body.

* The fornix is the only efferent outflow from the hippocampus.

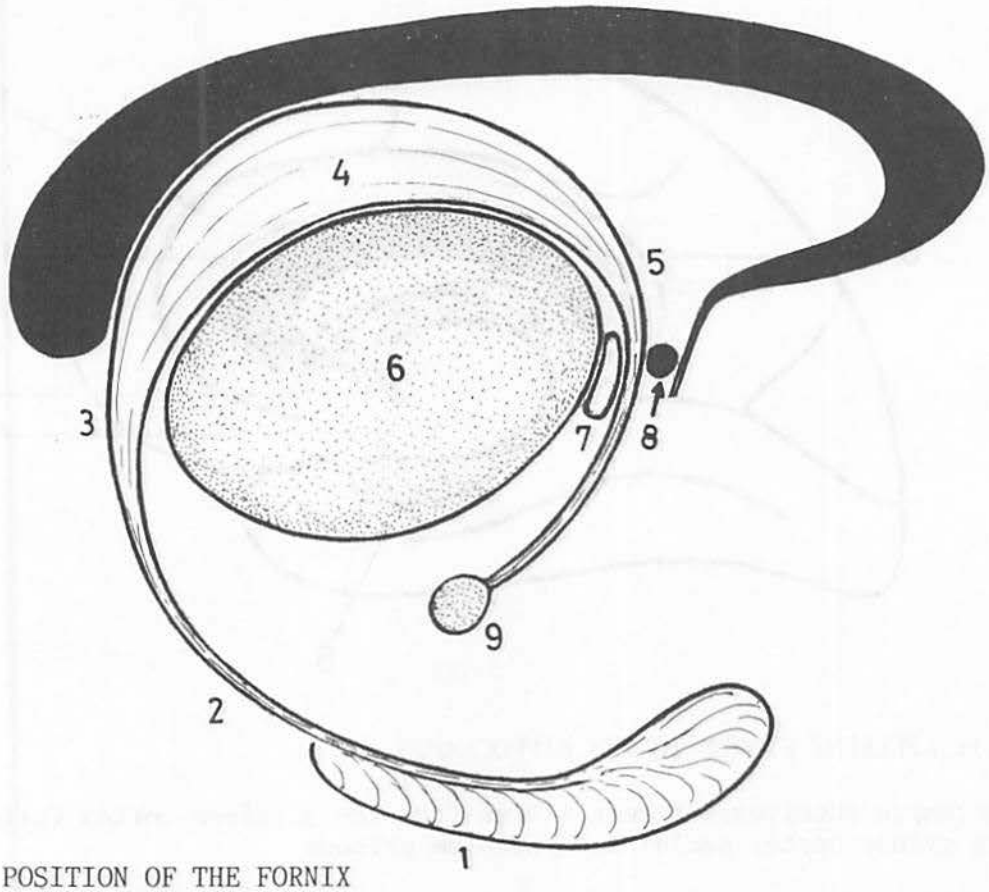


Fig.(300): POSITION OF THE FORNIX

The body of the fornix lies in the midline just below the trunk of the corpus callosum and septum pellucidum.

1. hippocampus.
2. fimbria.
3. crus of the fornix.
4. body of the fornix.
5. column of the fornix.
6. thalamus.
7. interventricular foramen.
8. anterior commissure.
9. mamillary body.

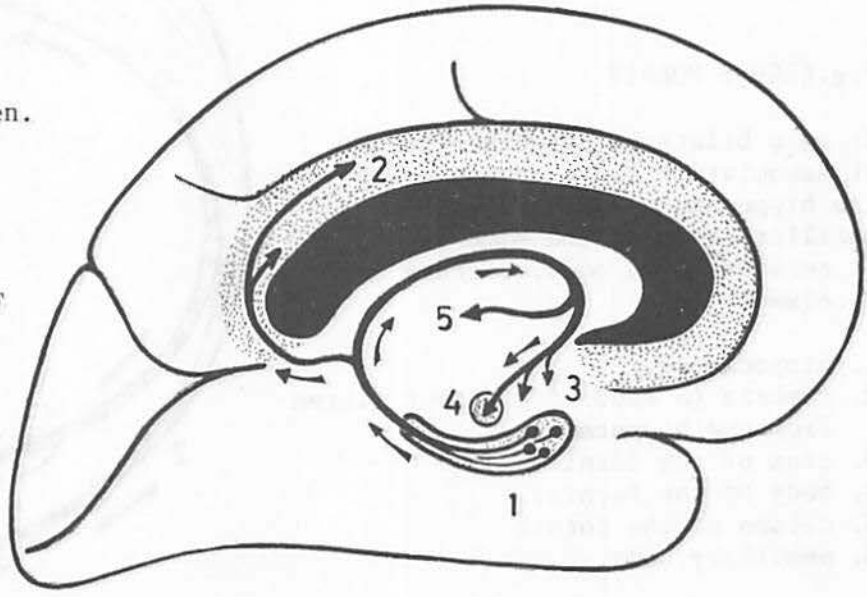


Fig.(301): DISTRIBUTION OF THE FIBRES OF THE FORNIX

These fibres end mainly into the mamillary body and anterior hypothalamic nuclei.

1. hippocampus.
2. to cingulate gyrus.
3. to anterior hypothalamic nuclei.
4. mamillary body.
5. to habenular nucleus.

WHITE MATTER OF THE BRAIN

ASSOCIATION FIBRES

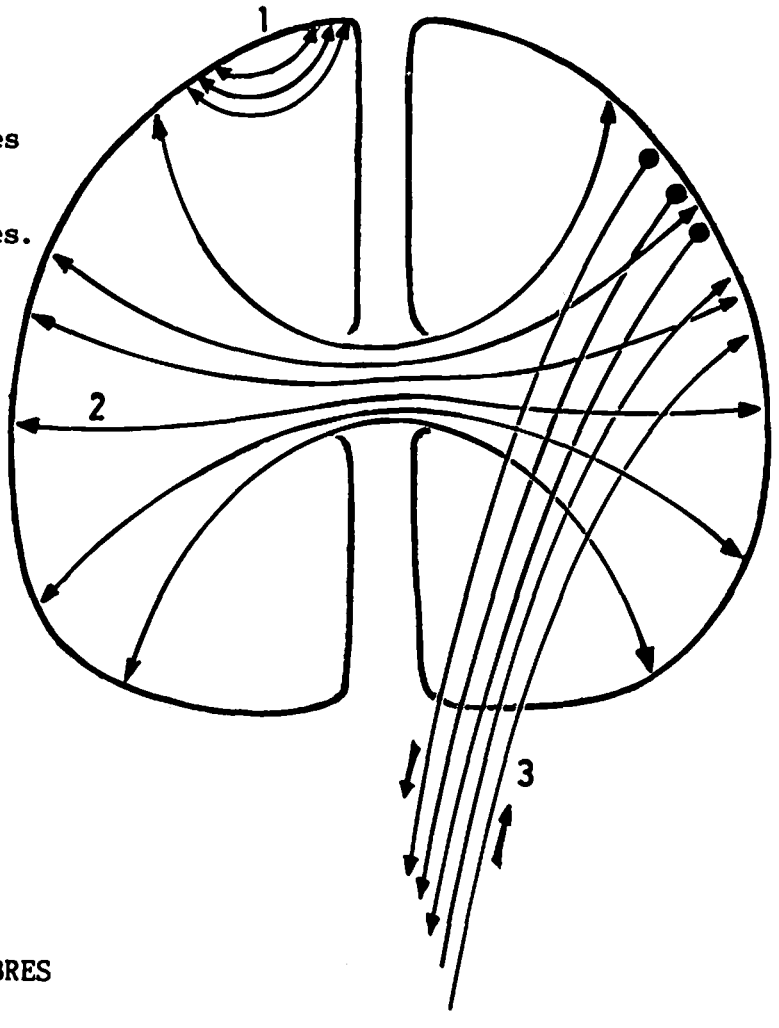


Fig.(302): TYPES OF FIBRES

There are 3 types of nerve fibres in the white matter of the cerebrum. These are association, commissural and projection fibres.

1. short association fibres: connect adjacent cortical areas in the same hemisphere.
2. commissural fibres: connect corresponding parts of the 2 hemispheres together.
3. projection fibres: connect the cerebral cortex with lower centres in the brain-stem and spinal cord. These are either corticofugal fibres (descending) or corticopetal fibres (ascending).

Fig.(303): SHORT ASSOCIATION FIBRES

These fibres run immediately beneath the cortex and connect adjacent gyri together.

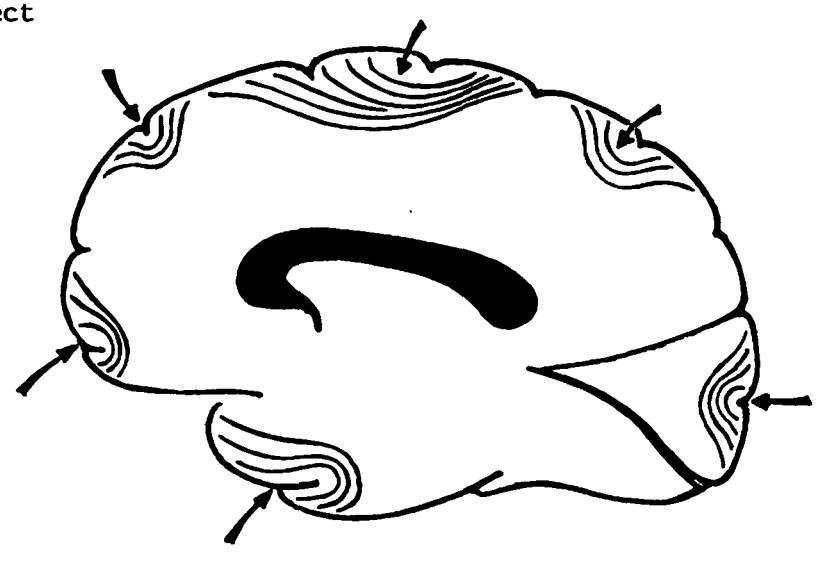


Fig.(304): UNCINATE FASCICULUS

It is a hook-like bundle which connects the cortex of the orbital surface of the frontal lobe with the cortex of the temporal pole. It crosses the stem of the lateral sulcus.

1. frontal pole.
2. temporal pole.
3. uncinate fasciculus.

Fig.(305): INFERIOR LONGITUDINAL FASCICULUS

It is an association bundle extending from the occipital pole to the temporal pole.

1. temporal pole.
2. inferior longitudinal fasciculus.
3. occipital pole.

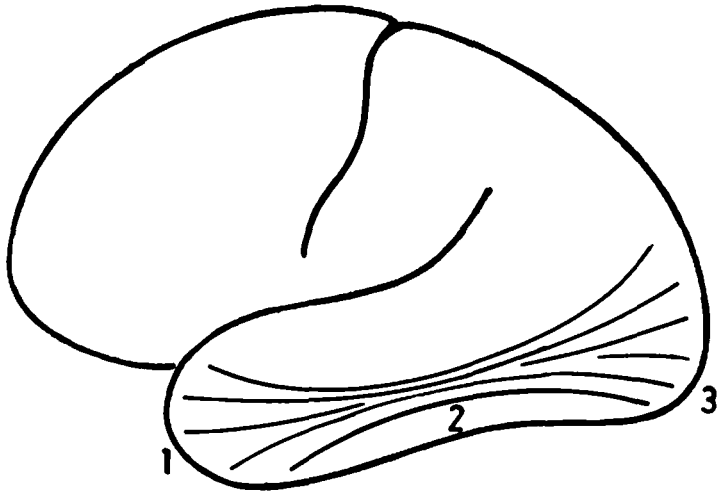


Fig.(306): CINGULUM

It is a curved bundle of association fibres which runs within the cingulate gyrus and continues in the parahippocampal gyrus.

1. cingulum in the cingulate gyrus.
2. cingulum in the parahippocampal gyrus.

Fig.(307): SUPERIOR LONGITUDINAL FASCICULUS

It is an association bundle which begins in the anterior part of the frontal lobe and runs backwards above the insula and lateral to the corona radiata. It curves behind and below the insula to enter the temporal lobe. It gives off branches to the occipital cortex.

1. superior longitudinal fasciculus in the frontal lobe.
2. course of the fasciculus above the insula.
3. branches to the occipital cortex.
4. end of the fasciculus in the temporal lobe.
5. insula.

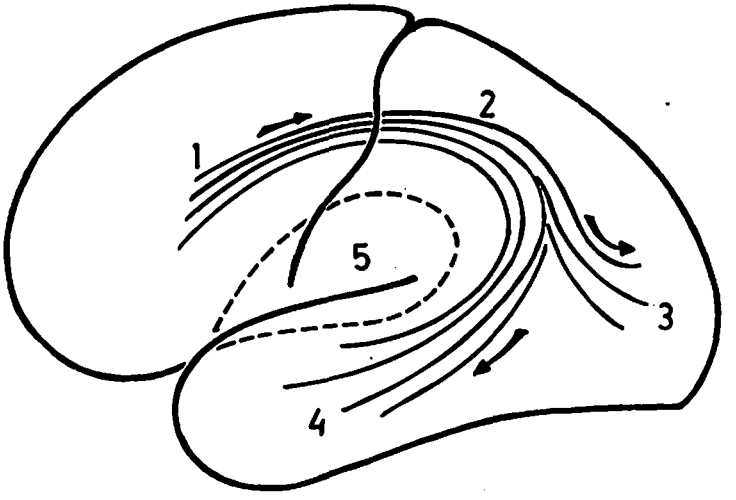
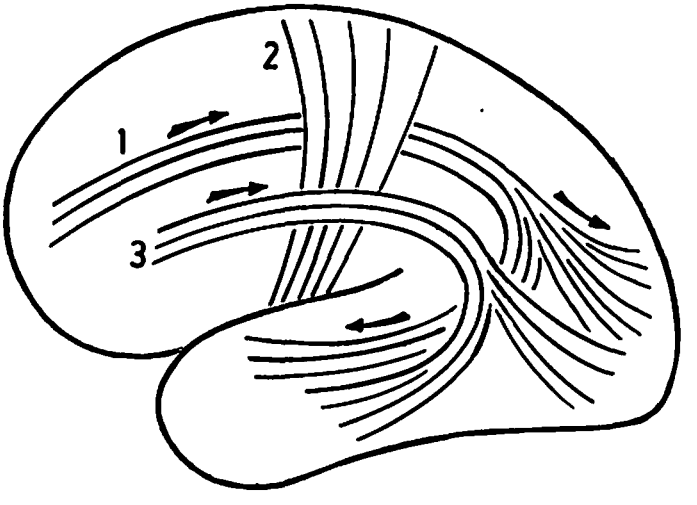


Fig.(308): FRONTO-OCCIPITAL FASCICULUS

It is an association bundle which begins at the frontal pole and passes backwards deep to the corona radiata to end in the occipital cortex as well as in the temporal lobe.

1. fronto-occipital fasciculus.
2. corona radiata (between the fronto-occipital fasciculus and the superior longitudinal fasciculus).
3. superior longitudinal fasciculus (runs parallel and lateral to the fronto-occipital fasciculus).



COMMISSURAL FIBRES

Commissural fibres connect corresponding areas of the 2 hemispheres together. They are grouped into the following commissures: anterior commissure, posterior commissure, habenular commissure, hippocampal commissure and corpus callosum.

CORPUS CALLOSUM

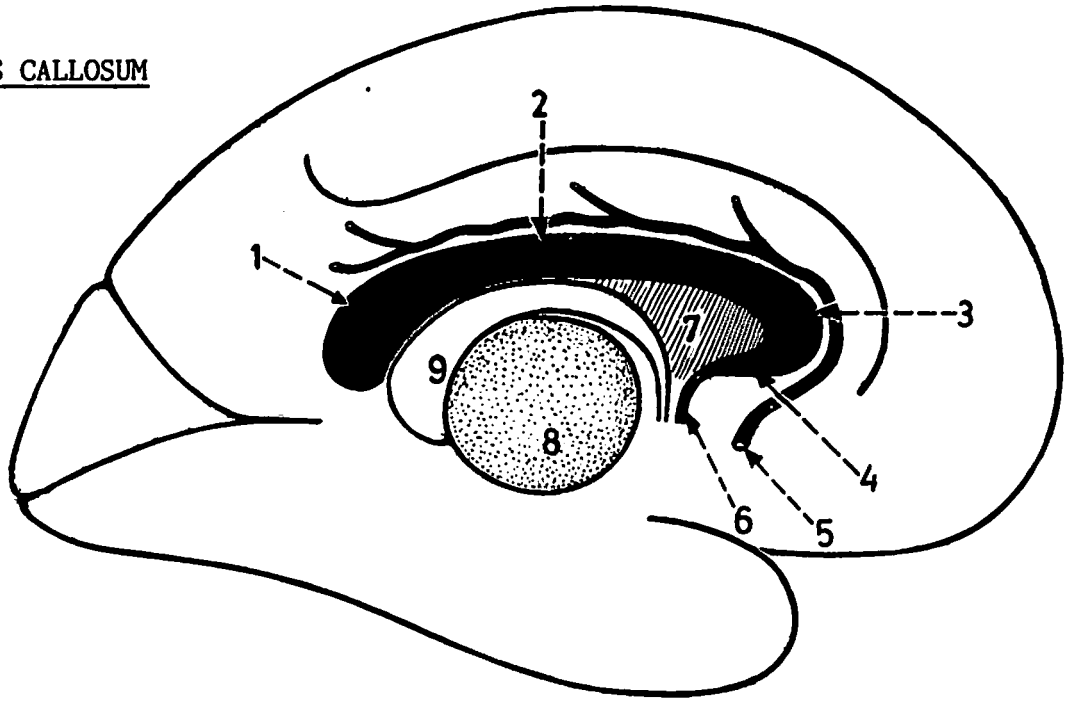


Fig.(309): POSITION AND PARTS OF CORPUS CALLOSUM

The corpus callosum is the largest commissure. In a sagittal section it appears as an arched structure situated in the central area of the medial surface. It consists of 4 parts: rostrum, genu, trunk and splenium.

1. splenium of corpus callosum (posterior end).
2. trunk of corpus callosum.
3. genu of corpus callosum (anterior end).
4. rostrum (extends backwards from the genu to the lamina terminalis).
5. anterior cerebral artery curving around the genu.
6. lamina terminalis.
7. septum pellucidum.
8. thalamus.
9. fornix.

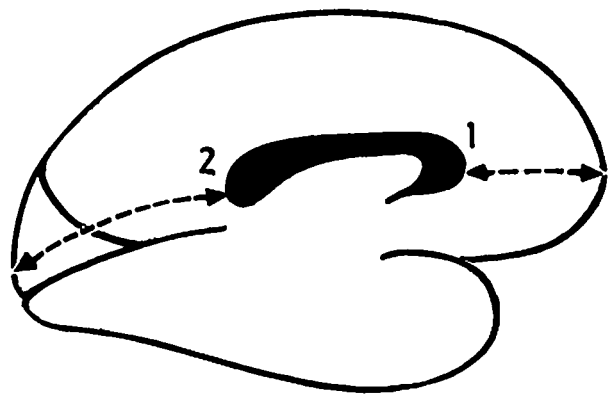


Fig.(310): POSITION OF THE CORPUS CALLOSUM IN RELATION TO THE POLES OF THE CEREBRUM

The distance between the genu and the frontal pole is shorter than the distance between the splenium and the occipital pole.

1. genu; 2. splenium.

Fig.(311): STRUCTURES RELATED TO THE LOWER SURFACE OF THE TRUNK OF CORPUS CALLOSUM

These are the body of the fornix posteriorly, and the septum pellucidum anteriorly.

1. trunk of corpus callosum.
2. genu.
3. rostrum.
4. lamina terminalis.
5. septum pellucidum (a thin vertical median partition).
6. anterior commissure.
7. interventricular foramen.
8. column of the fornix.
9. body of the fornix.

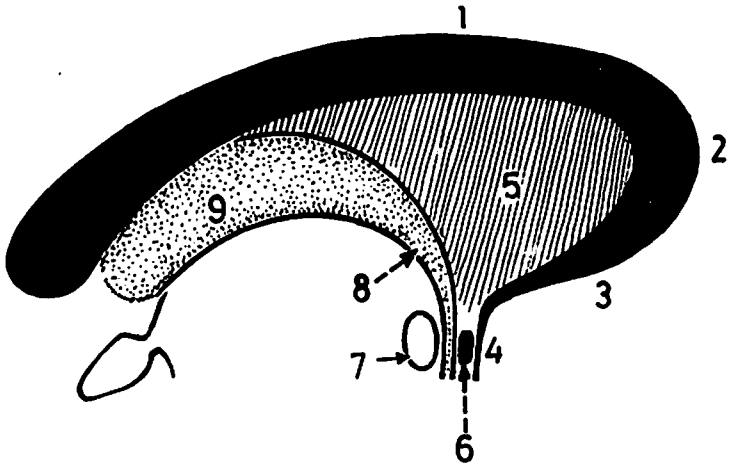


Fig.(312): RELATIONS OF THE TRUNK OF CORPUS CALLOSUM (coronal section)

Its upper surface is related to the indusium griseum, lower border of falx cerebri and anterior cerebral vessels. Its lower surface is related to the septum pellucidum, body of the fornix and central parts of the 2 lateral ventricles.

1. callosal sulcus (between the corpus callosum and cingulate gyrus).
2. cingulate gyrus.
3. falx cerebri.
4. anterior cerebral artery.
5. indusium griseum.
6. corpus callosum (T.S.).
7. central part of lateral ventricle.
8. septum pellucidum.

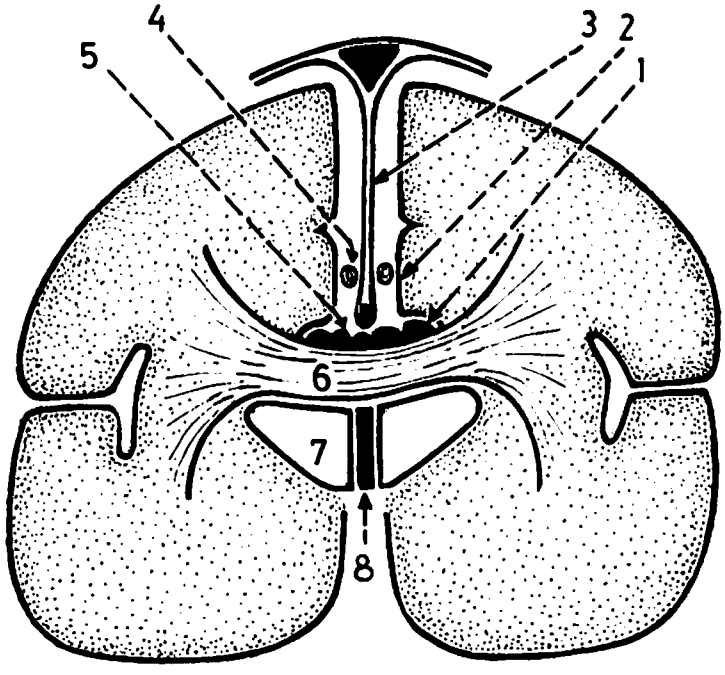
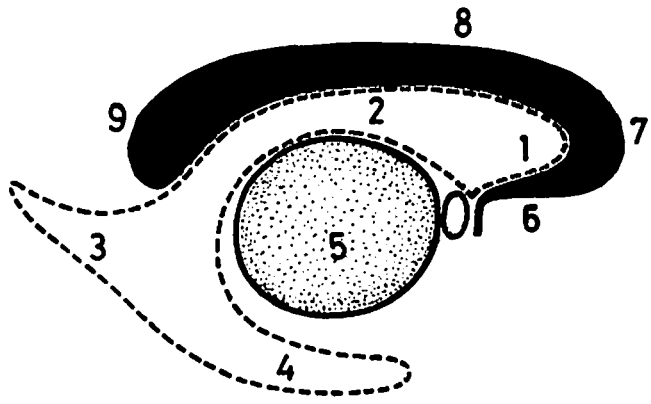


Fig.(313): RELATIONS OF THE CORPUS CALLOSUM TO LATERAL VENTRICLE

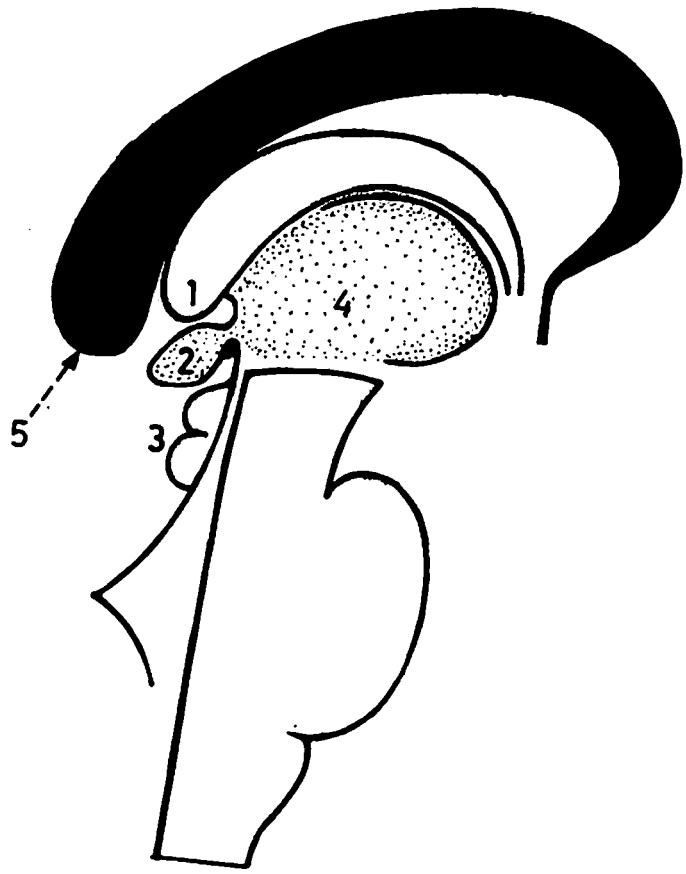


The trunk of the corpus callosum forms the roof of the central part and anterior horn of the lateral ventricle. The genu forms the anterior wall of the anterior horn, while the rostrum forms the floor of the anterior horn.

1. anterior horn of lateral ventricle.
2. central part of lateral ventricle.
3. posterior horn of lateral ventricle.
4. inferior horn of lateral ventricle.
5. thalamus.
6. rostrum of corpus callosum.
7. genu of corpus callosum.
8. trunk of corpus callosum.
9. splenium of corpus callosum.

* Note that the posterior horn of the ventricle is related to the forceps major and tapetum of corpus callosum, while the inferior horn is related only to the tapetum.

Fig.(314): STRUCTURES UNDER COVER OF THE SPLENIUM



These are the crura of the fornix, pineal body, pulvinar of the thalamus and tectum of midbrain.

1. crus of the fornix.
2. pineal body.
3. tectum of midbrain.
4. thalamus.
5. splenium of corpus callosum.

Fig.(315): TRANSVERSE FISSURE OF THE CEREBRUM

This fissure lies under cover of the splenium and transmits the tela choroidea of the 3rd ventricle as well as the 2 internal cerebral veins.

1. 3rd ventricle.
2. pineal body.
3. arrow in the transverse fissure of the cerebrum leading to the roof of the 3rd ventricle.
4. splenium of the corpus callosum.

Fig.(316): STRUCTURES BEHIND THE SPLENIUM

These are the posterior part of the lower border of falx cerebri, great cerebral vein and beginning of the straight sinus.

1. internal cerebral vein in the roof of the 3rd ventricle.
2. great cerebral vein (behind the splenium).
3. straight sinus.
4. falx cerebri.
5. splenium of corpus callosum.

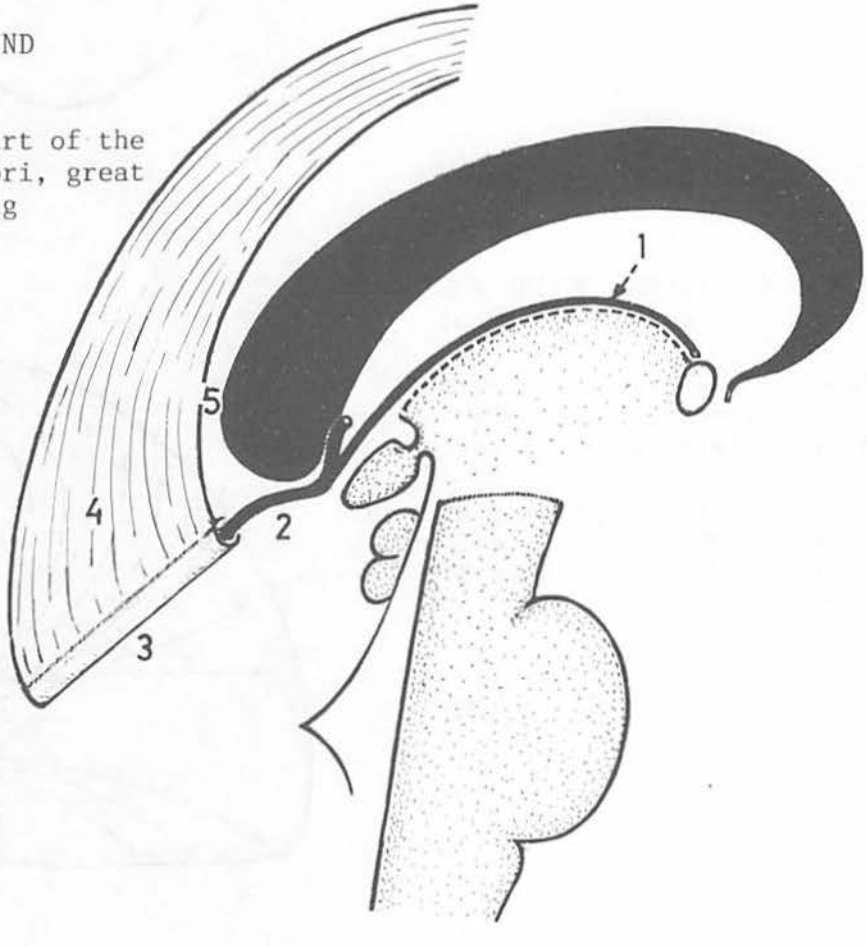


Fig.(317): DIRECTION OF FIBRES OF THE CORPUS CALLOSUM

1. forceps minor: these are fibres of the genu which extend forwards towards the frontal poles of the 2 hemispheres.
2. fibres of the trunk of corpus callosum passing transversely from side to side.
3. forceps major: these are fibres of the splenium which extend backwards towards the occipital pole.

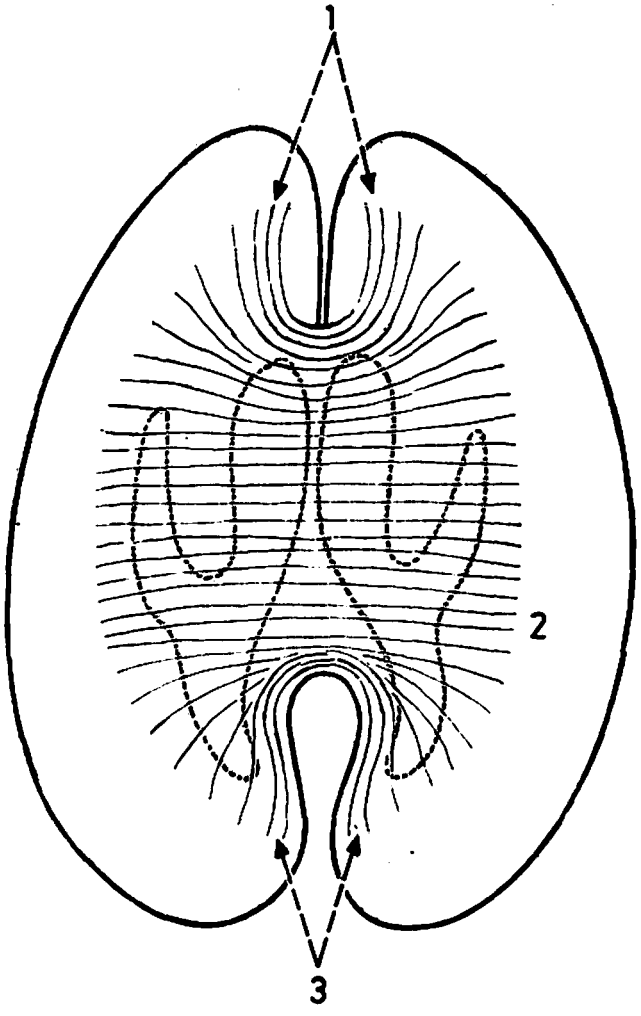


Fig.(318): FIBRES OF THE ROSTRUM (coronal section)

These fibres extend transversely in the floor of the anterior horns of the 2 lateral ventricles.

1. fibres of the anterior part of the trunk of corpus callosum.
2. anterior horn of lateral ventricle.
3. rostrum.

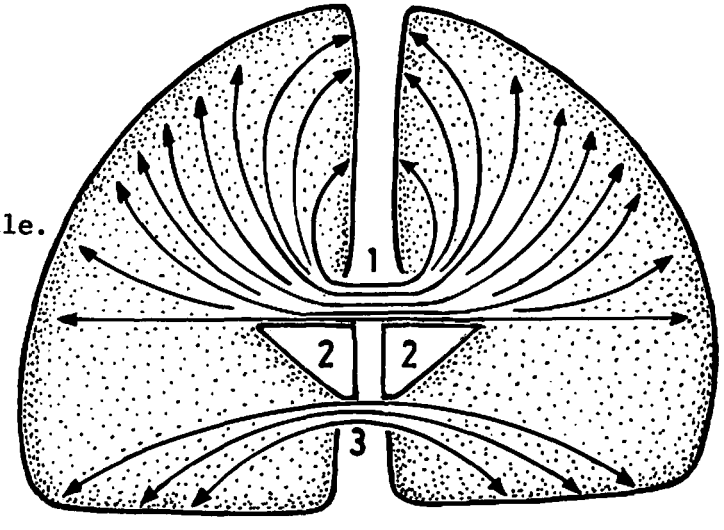
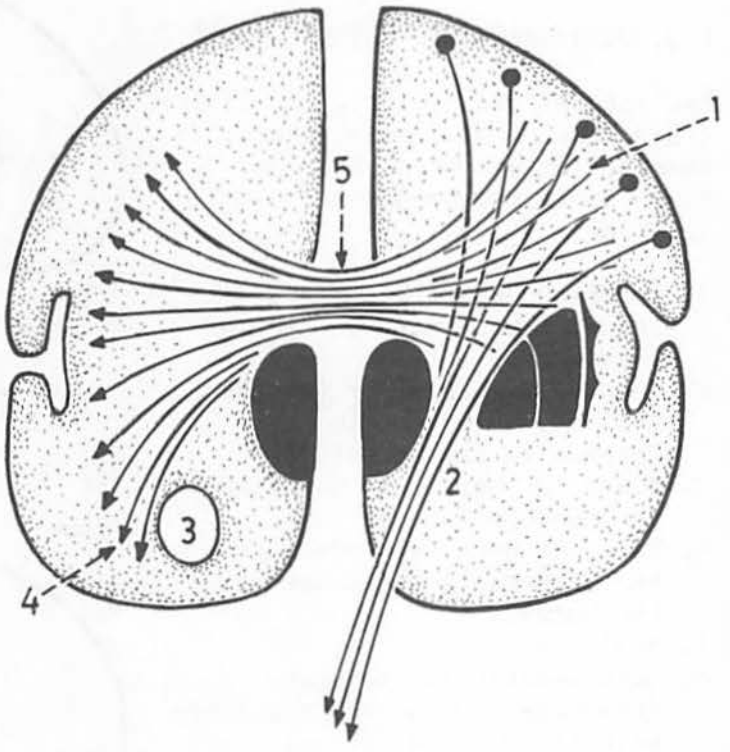


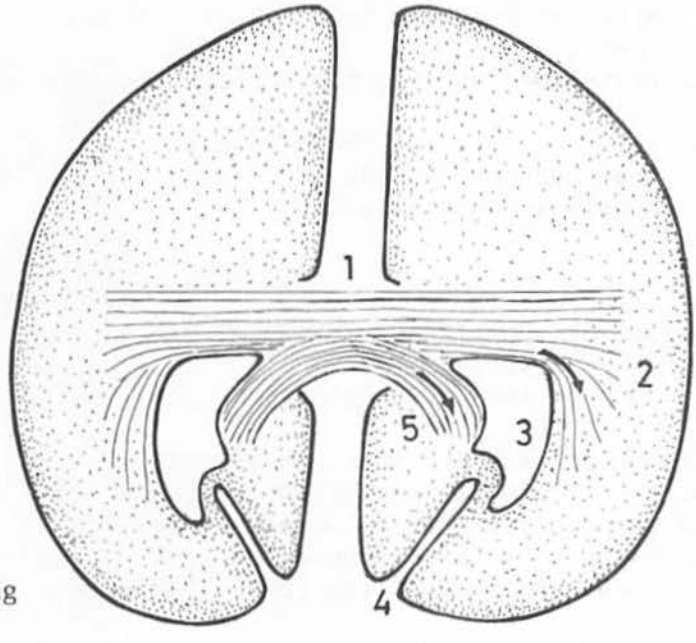
Fig.(319): FIBRES OF THE TRUNK OF CORPUS CALLOSUM (coronal section)



They intersect the fibres of the corona radiata, and descend on the lateral wall of the inferior horn of lateral ventricle to form the tapetum.

1. fibres of corpus callosum intersecting the corona radiata.
2. internal capsule.
3. inferior horn of lateral ventricle.
4. tapetum of corpus callosum.
5. trunk of corpus callosum.

Fig.(320): FIBRES OF THE SPLENIUM (coronal section)



These fibres form the forceps major and tapetum. The forceps major forms a bulge in the medial wall of the posterior horn of the lateral ventricle called the bulb of the posterior horn. The tapetum forms the roof and lateral wall of the posterior horn.

1. splenium.
2. tapetum.
3. posterior horn of the lateral ventricle.
4. calcarine sulcus bulging into the posterior horn to form the calcar avis.
5. fibres of the forceps major forming the bulb of posterior horn.

LATERAL VENTRICLE

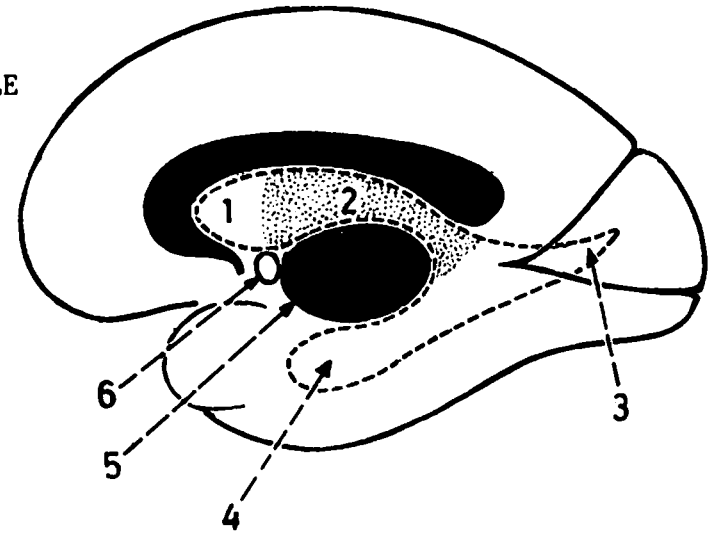


Fig.(321): PARTS OF LATERAL VENTRICLE

The lateral ventricle is the cavity inside the cerebral hemisphere. It consists of a central part and 3 horns (anterior, posterior and inferior).

1. anterior horn (the part in front of the interventricular foramen).
2. central part or body (extends from the interventricular foramen to the splenium).
3. posterior horn (extends into the occipital lobe).
4. inferior horn (extends into the temporal lobe as far as the uncus).
5. thalamus.
6. interventricular foramen (connects the lateral ventricle with the 3rd ventricle).

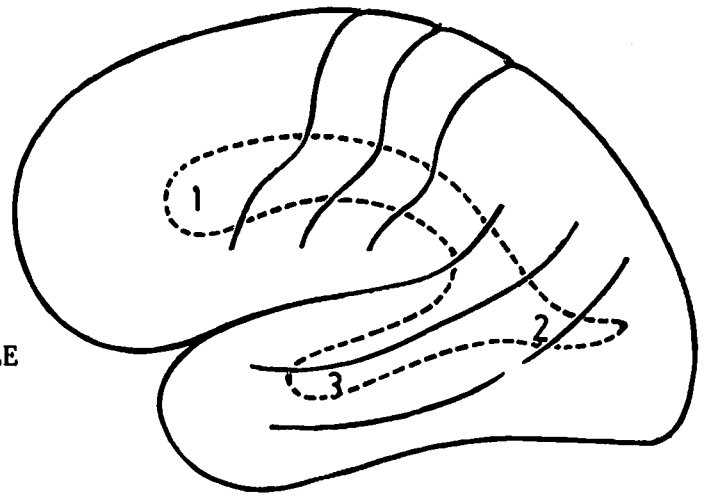


Fig.(322): HORNS OF LATERAL VENTRICLE (superolateral surface)

1. anterior horn (in the frontal lobe).
2. posterior horn (in the occipital lobe).
3. inferior horn (in the temporal lobe and corresponds to the superior temporal sulcus).

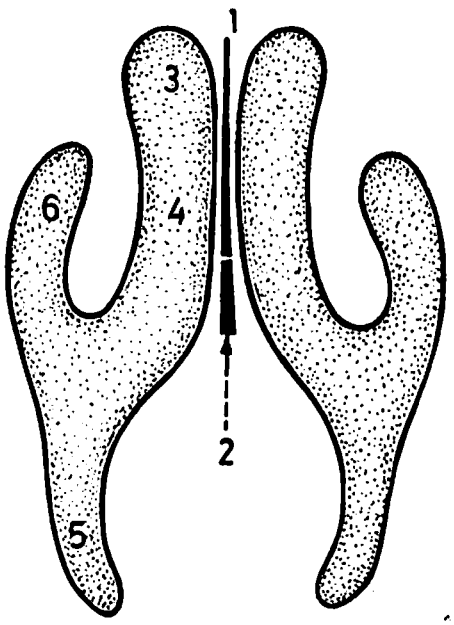
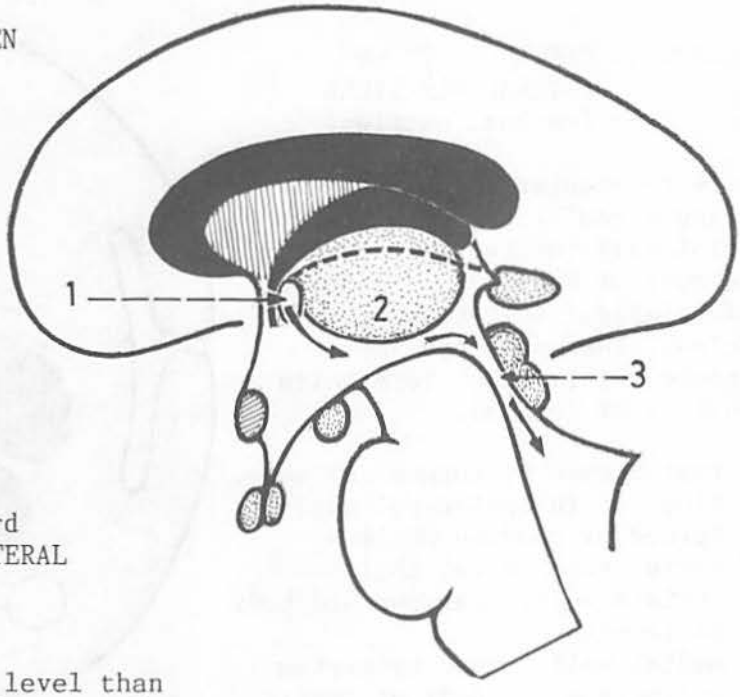


Fig.(323): OUTLINE OF THE 2 LATERAL VENTRICLES (seen from above)

The anterior horns and central parts of the 2 lateral ventricles lie close to the midline and are separated from each other by the septum pellucidum in front and body of the fornix behind.

1. septum pellucidum.
2. fornix.
3. anterior horn.
4. central part of lateral ventricle.
5. posterior horn.
6. inferior horn.

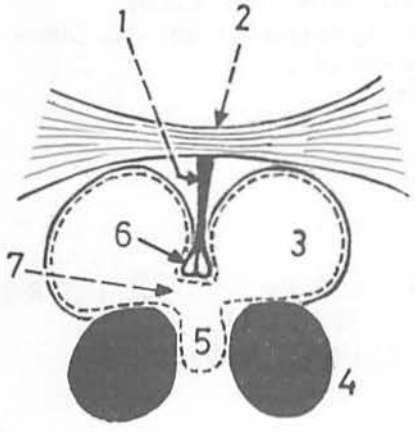
Fig.(324): INTERVENTRICULAR FORAMEN (FORAMEN OF MONRO)



it connects the lateral ventricle with the 3rd ventricle, and is bounded in front by the column of the fornix and behind by the anterior end of the thalamus.

1. interventricular foramen.
2. thalamus.
3. cerebral aqueduct.

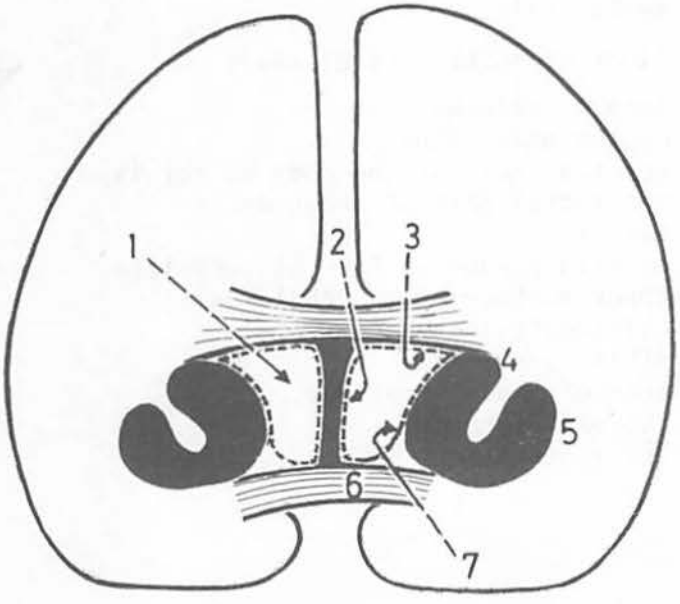
Fig.(325): RELATION BETWEEN THE 3rd VENTRICLE AND THE 2 LATERAL VENTRICLES (coronal section)



The 3rd ventricle lies at a lower level than the central parts of the 2 lateral ventricles. The roof of the 3rd ventricle is at the level of the floor of the central part of lateral ventricle

1. septum pellucidum.
2. corpus callosum.
3. central part of lateral ventricle.
4. thalamus.
5. 3rd ventricle.
6. columns of the fornix.
7. interventricular foramen.

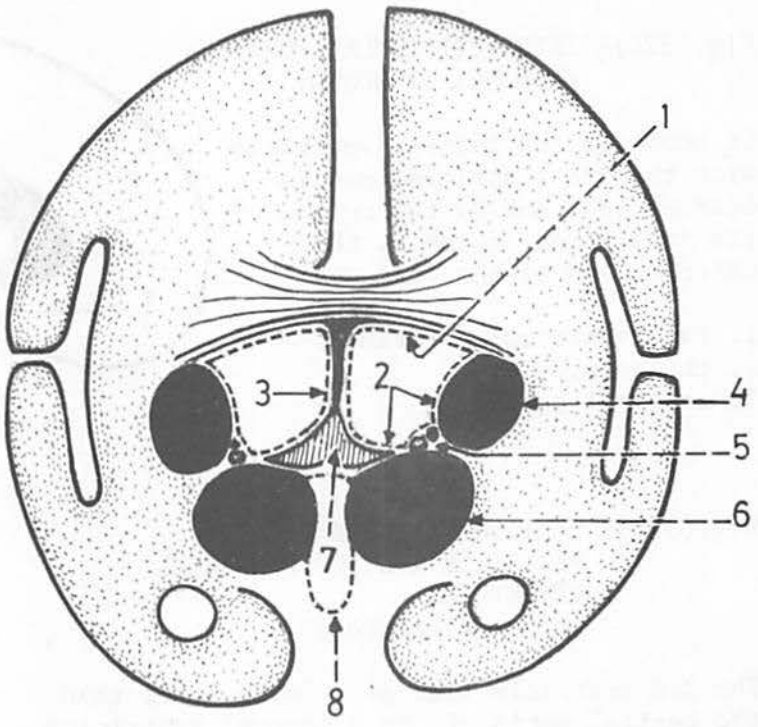
Fig.(326): ANTERIOR HORN OF LATERAL VENTRICLE (coronal section)



It is triangular in shape having a roof (corpus callosum), floor or inferolateral wall (rostrum and head of caudate), and medial wall (septum pellucidum).

1. anterior horn.
2. medial wall formed by septum pellucidum.
3. roof formed by corpus callosum.
4. head of caudate forming part of the inferolateral wall.
5. lentiform nucleus (fused with the head of the caudate).
6. rostrum of corpus callosum.
7. floor or inferolateral wall.

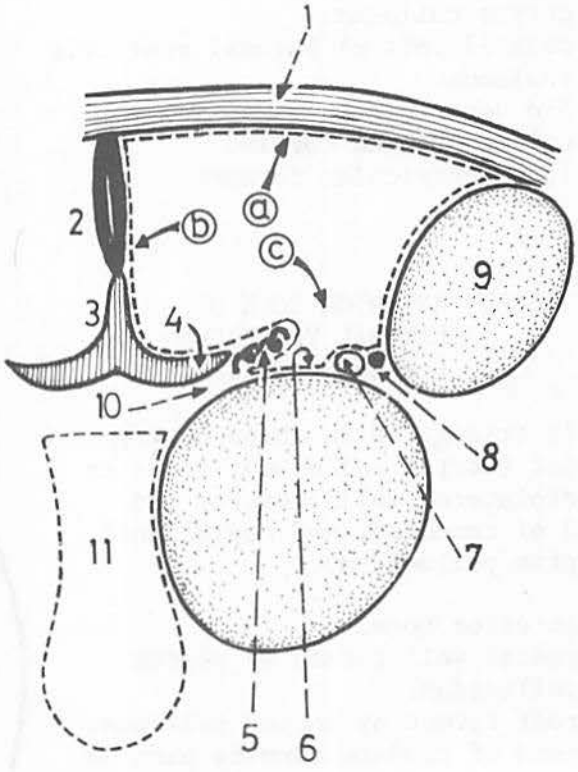
Fig.(327): CENTRAL PART OF LATERAL VENTRICLE (coronal section)



It is triangular in shape having a roof (corpus callosum), medial wall (septum pellucidum and body of fornix) and floor or inferolateral wall (caudate nucleus, thalamus, thalamostriate vein, stria terminalis and body of fornix).

1. roof formed by corpus callosum.
2. floor or inferolateral wall formed by caudate nucleus, stria terminalis, thalamostriate vein, thalamus and body of fornix).
3. medial wall formed by septum pellucidum and body of fornix.
4. body of caudate nucleus.
5. stria terminalis and thalamostriate vein.
6. thalamus.
7. body of fornix.
8. 3rd ventricle.

Fig.(328): CENTRAL PART OF LATERAL VENTRICLE (more details)



(a) roof.

(b) medial wall.

(c) floor or inferolateral wall.

1. corpus callosum.
2. septum pellucidum.
3. vertical part of the body of fornix.
4. horizontal part of the body of fornix.
5. choroid plexus of lateral ventricle.
6. upper surface of the thalamus.
7. thalamostriate vein.
8. stria terminalis.
9. body of caudate nucleus.
10. choroid fissure.
11. 3rd ventricle.

Fig.(329): POSTERIOR HORN
(coronal section)

It is triangular in shape having a roof (tapetum of corpus callosum), lateral wall (tapetum) and floor or inferomedial wall (bulb of posterior horn and calcar avis).

1. bulb of posterior horn formed by the forceps major.
2. roof formed by tapetum of corpus callosum.
3. lateral wall formed by the tapetum.
4. optic radiation (lateral to the tapetum).
5. calcarine sulcus.
6. calcar avis formed by the deep calcarine sulcus.
7. forceps major.

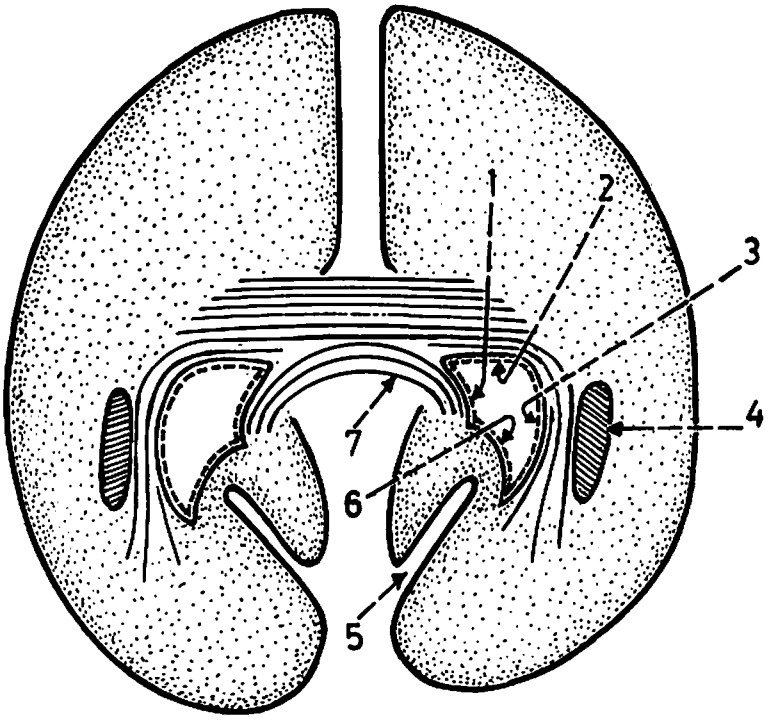


Fig.(330): INFERIOR HORN
(coronal section)

It is triangular in shape having a roof (stria terminalis and tail of caudate nucleus), lateral wall (tapetum) and floor or inferomedial wall (collateral eminence and hippocampus).

1. stria terminalis.
2. tail of caudate nucleus lateral to the stria).
3. tapetum of corpus callosum.
4. inferior horn.
5. collateral sulcus (produces a bulge in the floor called collateral eminence).
6. hippocampus (medial to the collateral eminence).
7. central part of lateral ventricle.

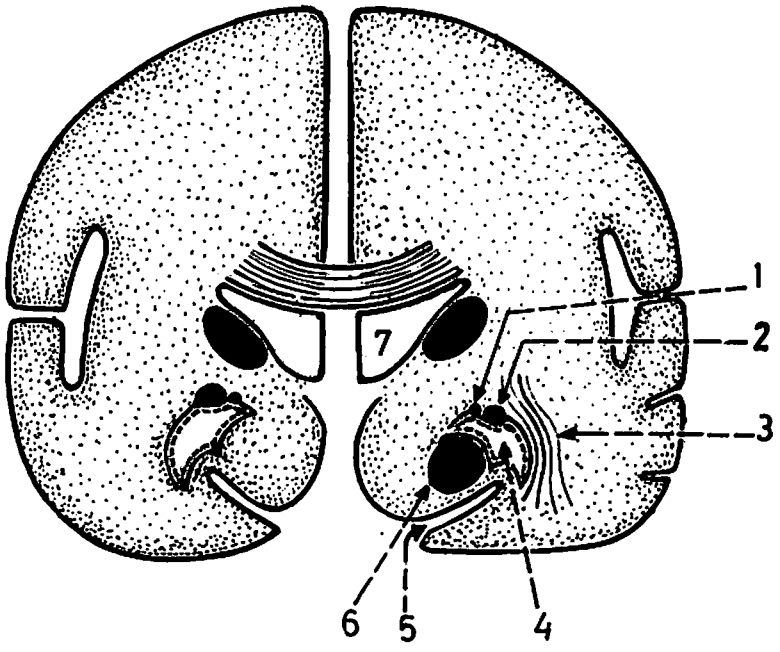
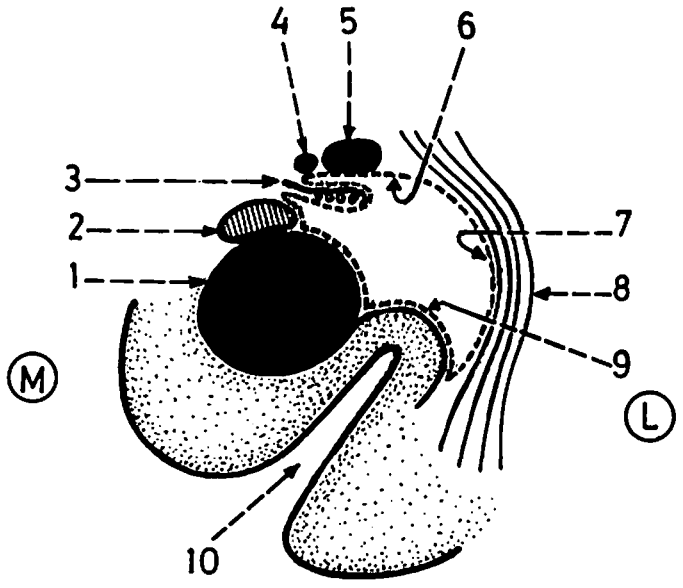


Fig.(331): INFERIOR HORN
(more details)

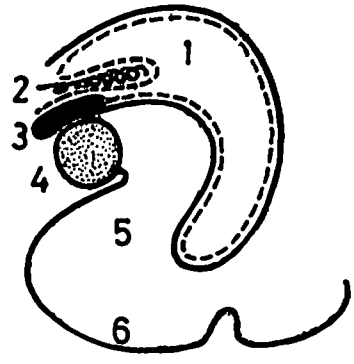


1. hippocampus (in the medial part of the floor).
2. fimbria.
3. choroid plexus invaginating the medial aspect of the inferior horn through the choroid fissure.
4. stria terminalis in the medial part of the roof.
5. tail of caudate nucleus in the lateral part of the roof.
6. roof of inferior horn.
7. lateral wall of inferior horn.
8. tapetum of corpus callosum forming the lateral wall.
9. collateral eminence in the lateral part of the floor.
10. collateral sulcus (deep).

* There are 2 deep sulci which produce elevations in the lateral ventricle. These are the calcarine sulcus producing the calcar avis in the posterior horn, and the collateral sulcus producing the collateral eminence in the inferior horn.

Fig.(332): CHOROID FISSURE AND PLEXUS
OF INFERIOR HORN

The choroid fissure of the inferior horn lies on its medial aspect just above the fimbria. The ependyma at the fissure is invaginated by the choroid plexus of the inferior horn.

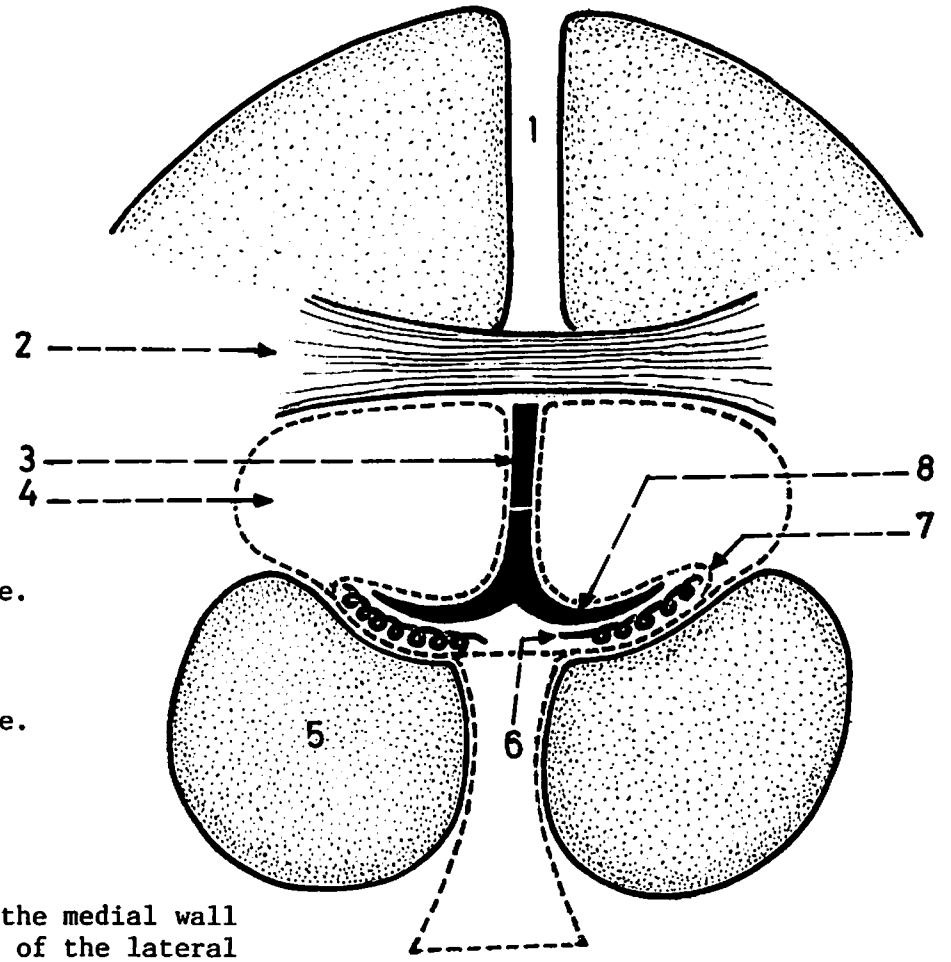


1. inferior horn.
2. choroid plexus entering the inferior horn through the choroid fissure.
3. fimbria (just below the choroid fissure and plexus).
4. dentate gyrus (just below the fimbria).
5. hippocampus.
6. parahippocampal gyrus.

* The choroid plexus is a plexus of fine arterioles which secrete C.S.F.

Fig. (333): CHOROID FISSURE OF LATERAL VENTRICLE

It lies on the medial aspect of the central part of the lateral ventricle between the body of fornix and thalamus. At this fissure the ependyma is invaginated by the choroid plexus of lateral ventricle.

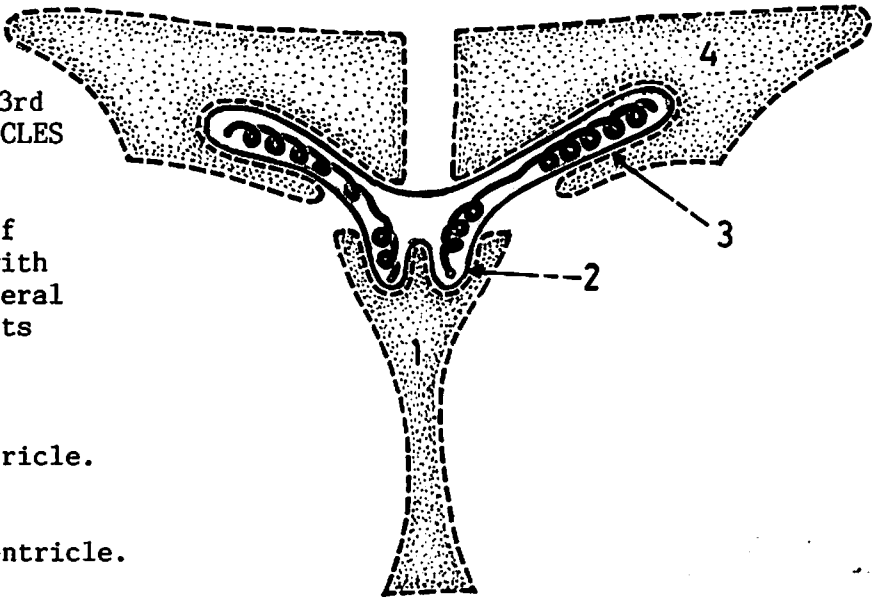


1. longitudinal cerebral fissure.
2. corpus callosum.
3. septum pellucidum.
4. central part of lateral ventricle.
5. thalamus.
6. choroid fissure.
7. choroid plexus of lateral ventricle.
8. horizontal part of body of fornix.

* Note that the body of the fornix has a vertical part in the medial wall of the central part of the lateral ventricle, and 2 horizontal parts each of which lies in the floor of the central part of the lateral ventricle.

Fig. (334): TELA CHOROIDEA OF 3rd AND LATERAL VENTRICLES

The choroid plexus of the 3rd ventricle invaginates its roof and is continuous laterally with the choroid plexus of the lateral ventricle which invaginates its medial wall.



1. 3rd ventricle.
2. tela choroidea of 3rd ventricle.
3. tela choroidea of lateral ventricle.
4. central part of lateral ventricle.

BASAL NUCLEI

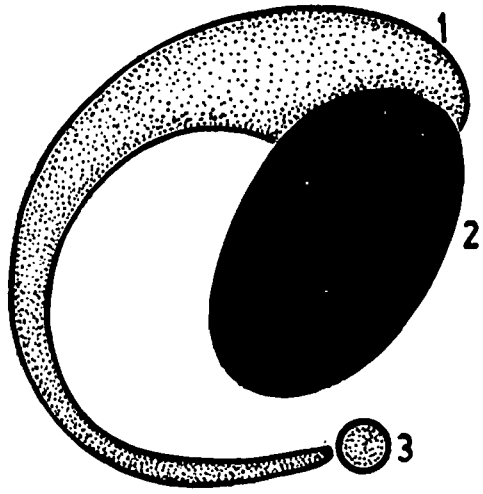


Fig.(335): COMPONENTS OF BASAL NUCLEI

These are the caudate nucleus, lentiform nucleus, amygdaloid body and claustrum. These nuclei are masses of grey matter situated in the white matter of the base of the brain.

1. caudate nucleus.
2. lentiform nucleus.
3. amygdaloid body.

* The lentiform and caudate nuclei are fused together at their anterior ends forming together the corpus striatum.

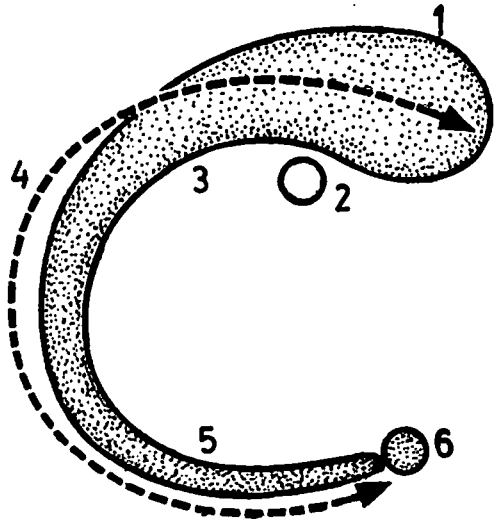


Fig.(336): PARTS OF CAUDATE NUCLEUS

The caudate nucleus is comma-shaped having a head, body and tail. The head and body of the nucleus lie in the floor of the anterior horn and central part of lateral ventricle, while its narrow tail lies in the roof of the inferior horn.

1. head of caudate nucleus (in front of the interventricular foramen).
2. interventricular foramen.
3. body of caudate nucleus.
4. line representing the anterior horn, central part and inferior horn of lateral ventricle.
5. tail of caudate nucleus (in the roof of inferior horn).
6. amygdaloid body (fuses with the tip of the tail of caudate nucleus).

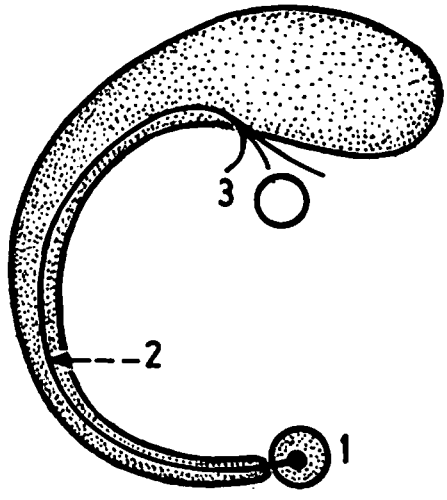
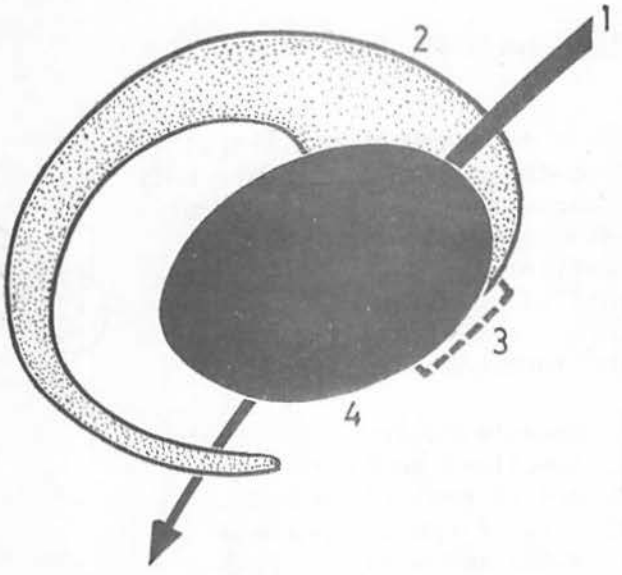


Fig.(337): STRIA TERMINALIS

It is a band of fibres which arises from the amygdaloid body and runs on the medial side of the caudate nucleus.

1. amygdaloid body.
2. stria terminalis.
3. termination of stria terminalis.

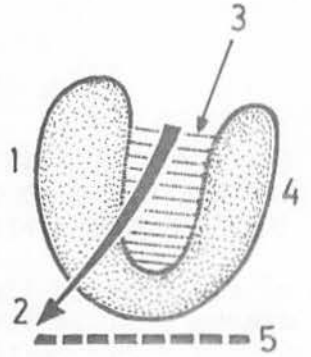
Fig.(338): POSITION OF THE ANTERIOR LIMB OF INTERNAL CAPSULE



The fibres of the anterior limb of internal capsule pass between the head of caudate nucleus and anterior part of the lentiform nucleus.

1. arrow representing the fibres of anterior limb of internal capsule.
2. head of caudate nucleus.
3. area of fusion between the head of caudate and anterior end of lentiform nucleus.
4. lentiform nucleus.

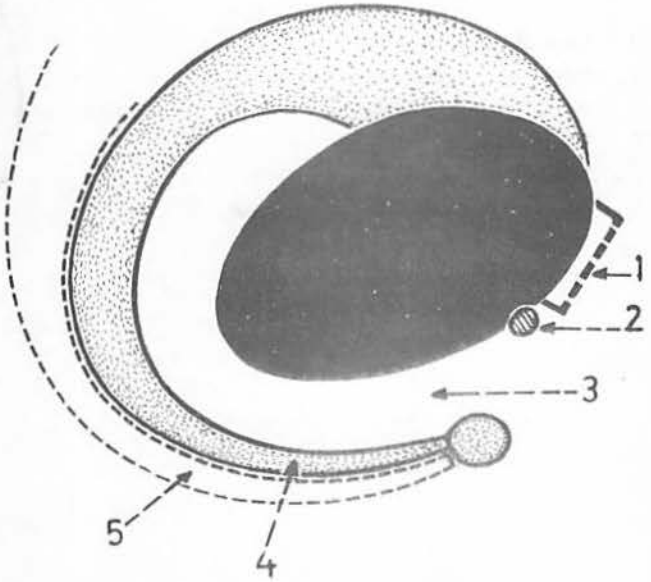
Fig.(339): ANTERIOR END OF CORPUS STRIATUM (coronal section)



The head of caudate and anterior end of lentiform nucleus fuse together at their lower parts. This area of fusion lies just above the anterior perforated substance. The gap between the head of caudate and the lentiform nucleus transmits the anterior limb of internal capsule and shows transverse strands of grey matter.

1. head of caudate nucleus (medial).
2. arrow representing the anterior limb of internal capsule.
3. transverse strands of grey matter between the 2 nuclei.
4. anterior end of lentiform nucleus (lateral).
5. anterior perforated substance (below).

Fig.(340): STRUCTURES BELOW THE LENTIFORM NUCLEUS



1. anterior perforated substance.
2. anterior commissure.
3. space transmitting the fibres of acoustic radiation.
4. tail of caudate nucleus.
5. inferior horn of lateral ventricle.

Fig. (341): FIBRES OF ACOUSTIC RADIATION

These fibres radiate laterally from the medial geniculate body towards the superior temporal gyrus. They lie between the lentiform nucleus above and tail of caudate below, and form the sublentiform part of the internal capsule.

1. caudate nucleus.
2. lentiform nucleus.
3. medial geniculate body.
4. tail of caudate nucleus.
5. acoustic radiation (sub-lentiform part of internal capsule).

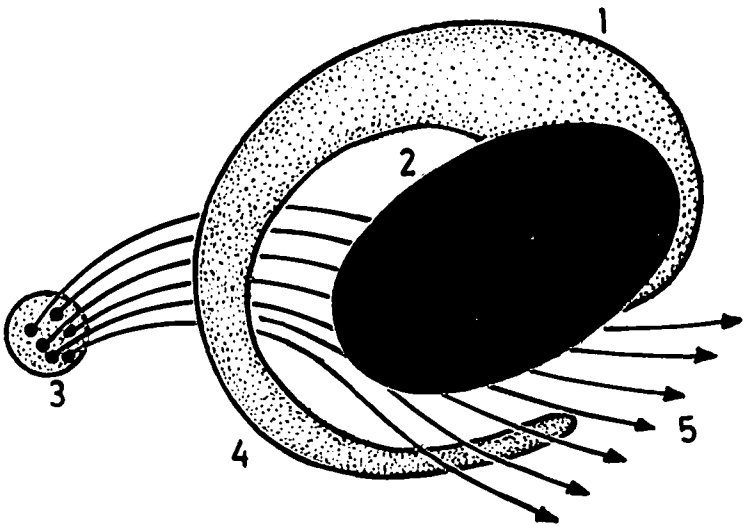


Fig.(342): POSITION OF INTERNAL CAPSULE IN RELATION TO THE CORPUS STRIATUM

The fibres of the anterior limb, genu and posterior limb of internal capsule pass between the lentiform nucleus laterally and the caudate nucleus medially. However, the tail of the caudate curves behind and lateral to the lower end of the internal capsule.

1. corona radiata.
2. head of caudate nucleus.
3. lentiform nucleus.
4. thalamus.
5. internal capsule.
6. tail of caudate nucleus.

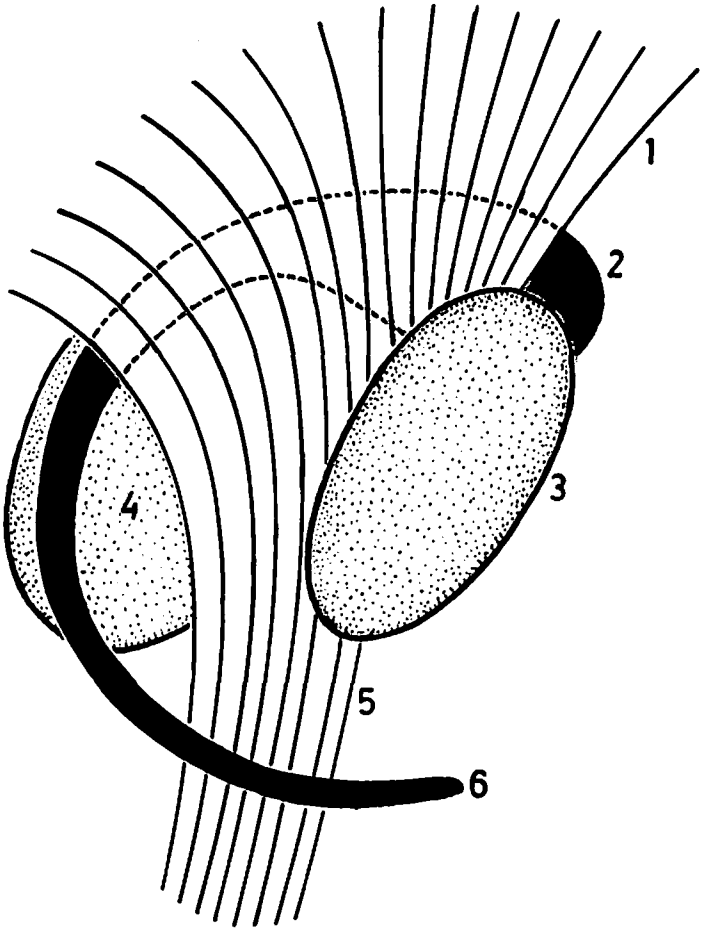


Fig.(343): FIBRES OF OPTIC RADIATION

These fibres radiate backwards from the lateral geniculate body towards the occipital cortex. They curve round the tail of caudate nucleus.

1. lateral geniculate body.
2. optic radiation.
3. tail of caudate nucleus.

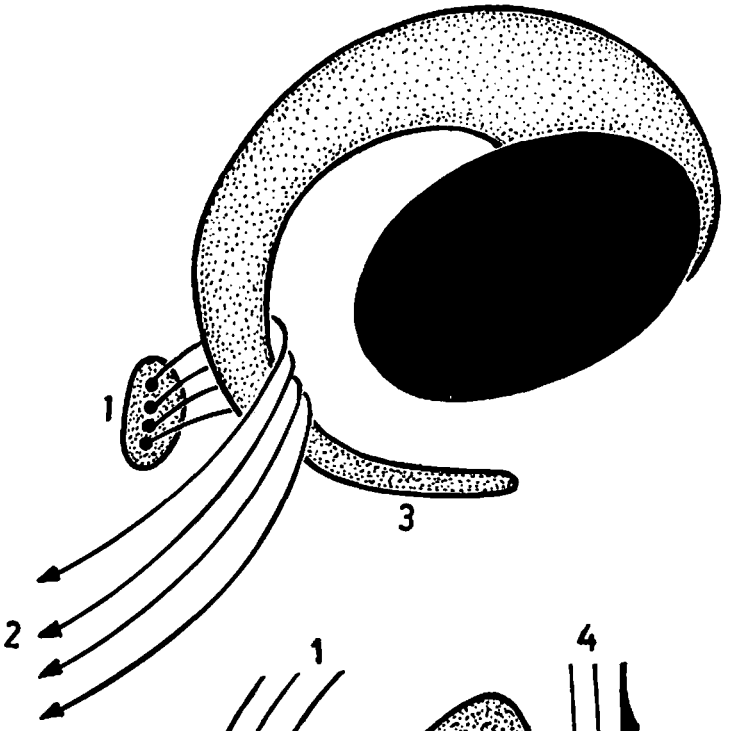


Fig.(344): LENTIFORM NUCLEUS

It is a biconvex mass of grey matter forming a part of corpus striatum. It is subdivided by a sheet of white matter into a dark lateral part called putamen and a pale medial part called globus pallidus.

1. internal capsule (medial).
2. globus pallidus (pale medial part).
3. putamen (dark lateral part).
4. external capsule (lateral and below).
5. claustrum (part of the basal nuclei).

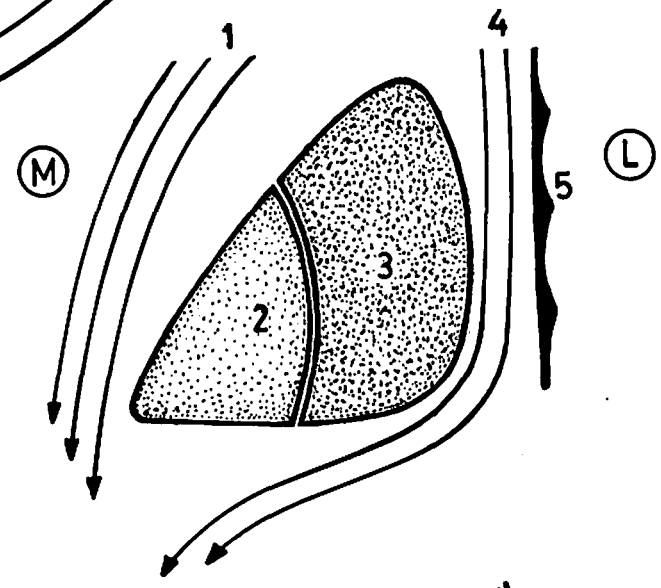
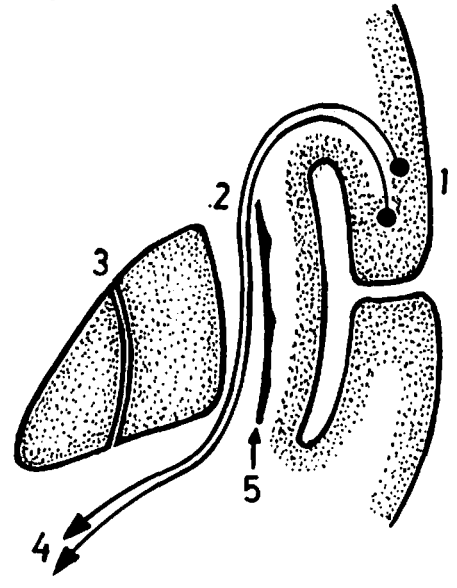


Fig.(345): EXTERNAL CAPSULE

It consists of fibres which arise in the frontoparietal operculum of the insula and descend lateral then below the lentiform nucleus to reach the subthalamus.

1. frontoparietal operculum.
2. external capsule lateral to the lentiform nucleus.
3. lentiform nucleus.
4. external capsule below the lentiform nucleus.
5. claustrum (a thin sheet of grey matter lateral to the external capsule).



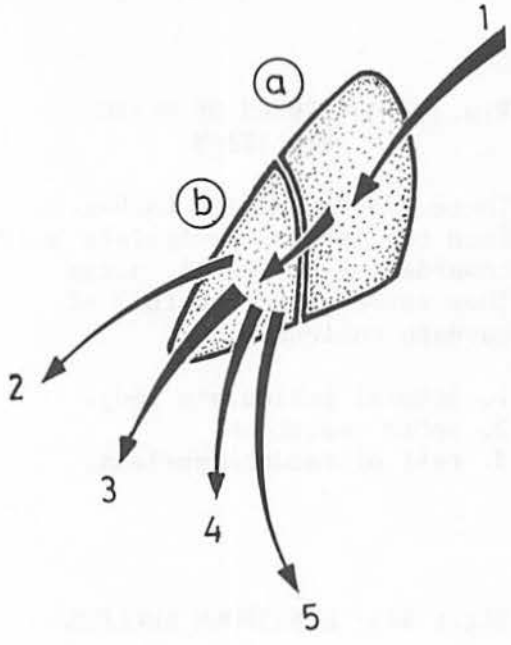


Fig.(346): INFLOW AND OUTFLOW OF LENTIFORM NUCLEUS

The putamen receives all afferent fibres coming to the lentiform nucleus, while the globus pallidus gives off all efferent fibres.

(a) putamen.

(b) globus pallidus.

1. afferent fibres.
2. ansa lenticularis.
3. fasciculus lenticularis.
4. thalamic fasciculus.
5. subthalamic fasciculus.

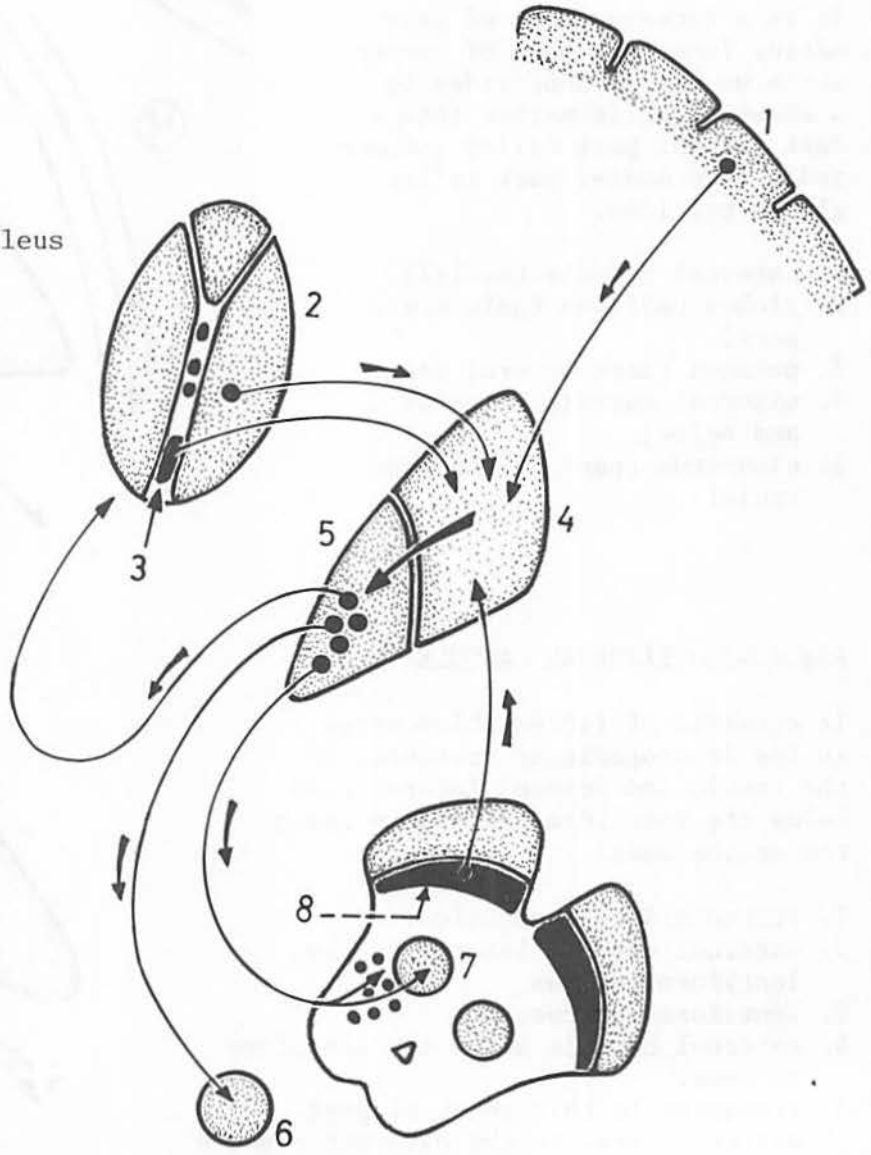


Fig.(347): CONNECTIONS OF CORPUS STRIATUM

The putamen and caudate nucleus receive afferents from the cerebral cortex, medial nucleus of thalamus and substantia nigra of mid-brain. The globus pallidus sends efferents to the thalamus, subthalamus and tegmentum of the midbrain.

1. premotor area of frontal cortex.
2. medial nucleus of thalamus.
3. intralaminar nuclei of thalamus.
4. putamen.
5. globus pallidus.
6. subthalamic nucleus.
7. red nucleus and reticular formation of midbrain.
8. substantia nigra.

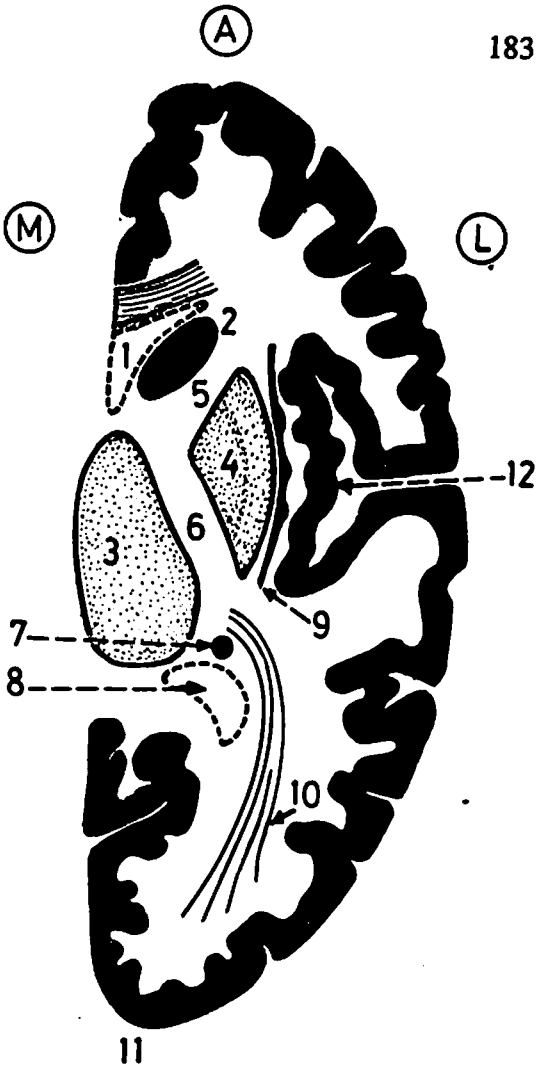


Fig.(348): CORPUS STRIATUM AND INTERNAL CAPSULE IN HORIZONTAL SECTION

1. anterior horn of lateral ventricle.
2. head of caudate nucleus.
3. thalamus (on the medial margin of the section).
4. lentiform nucleus.
5. anterior limb of internal capsule (between head of caudate and lentiform nucleus).
6. posterior limb of internal capsule (between thalamus and lentiform nucleus).
7. tail of caudate nucleus.
8. beginning of inferior horn of lateral ventricle.
9. claustrum (lateral to the lentiform nucleus).
10. optic radiaiton.
11. occipital pole.
12. insula.

* The medial border of the horizontal section is identified by being straight and shows the thalamus at its middle. The lateral border is identified by being convex and shows the insula.

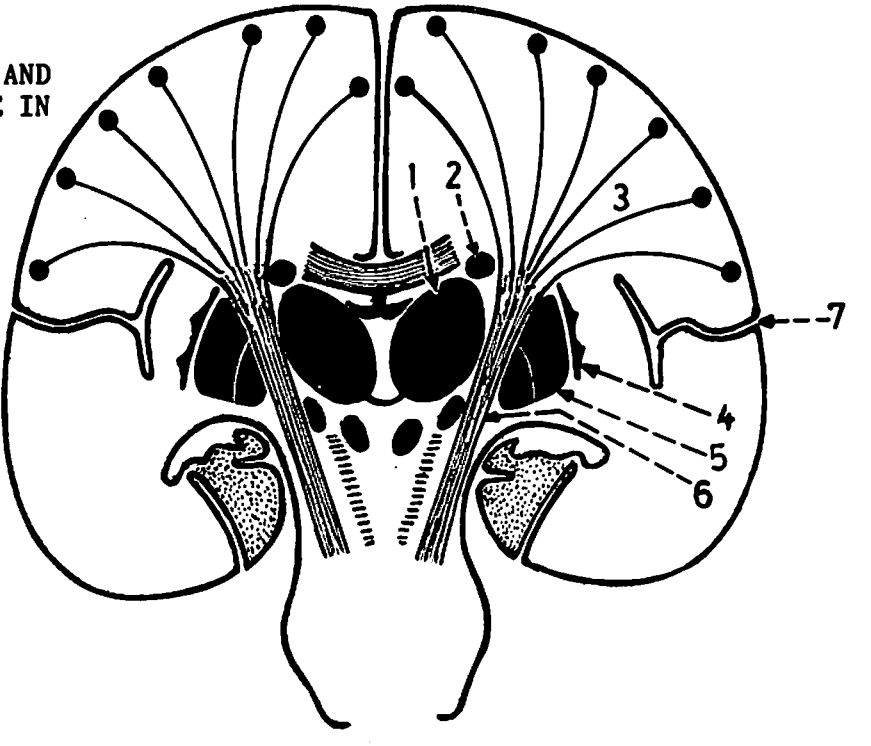
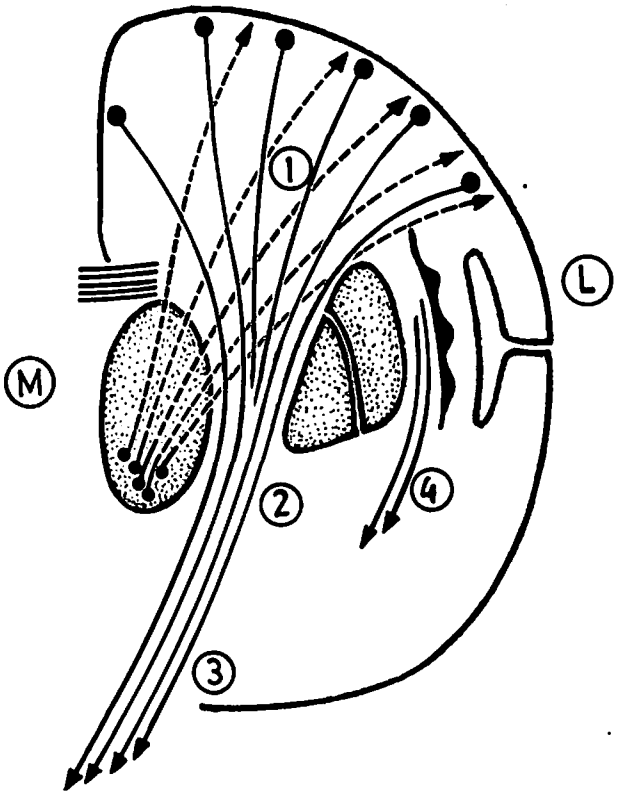


Fig.(349): CORPUS STRIATUM AND INTERNAL CAPSULE IN CORONAL SECTION

1. thalamus.
2. body of caudate nucleus.
3. corona radiata.
4. claustrum.
5. lentiform nucleus.
6. internal capsule.
7. insula.

INTERNAL CAPSULE

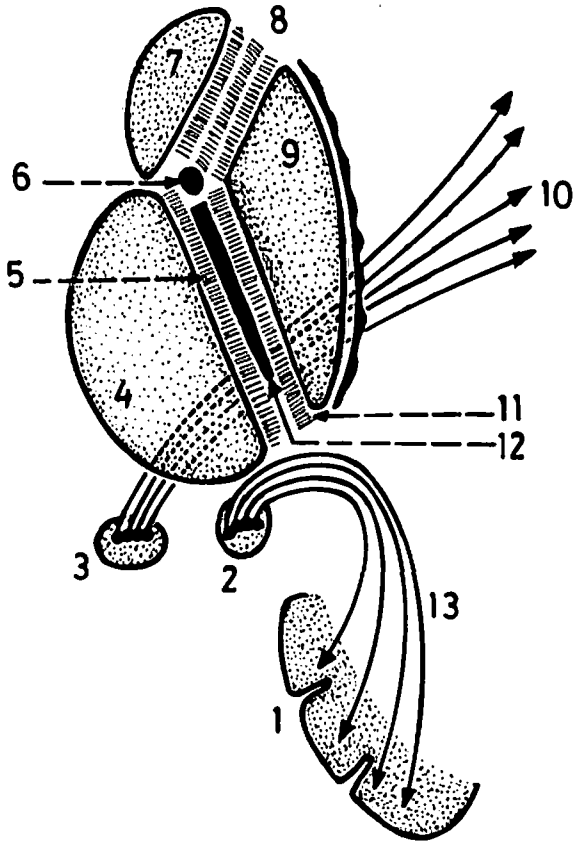
Fig.(350): POSITION OF INTERNAL CAPSULE
(coronal section)



The internal capsule lies between the thalamus and caudate nucleus medially and lentiform nucleus laterally. It is continued upwards as the corona radiata and downwards as the crus cerebri.

1. corona radiata.
2. internal capsule.
3. crus cerebri of midbrain.
4. external capsule (lateral to the lentiform nucleus).

Fig.(351): PARTS OF INTERNAL CAPSULE
(horizontal section)

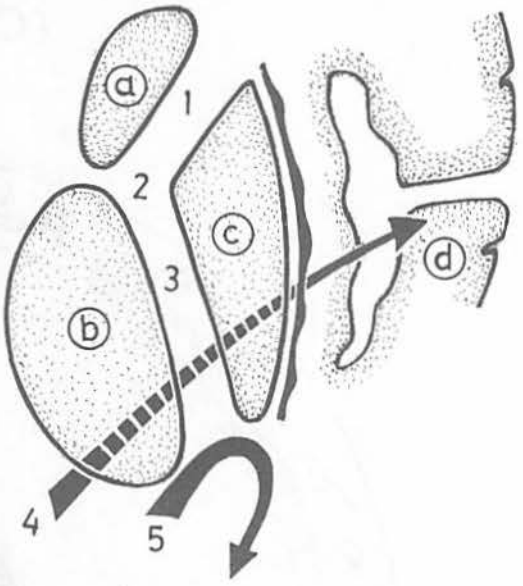


The internal capsule is L-shaped having an anterior limb, genu and posterior limb. In addition it has a retrolentiform part (behind) and a sublentiform part (below).

1. cortex of occipital lobe.
2. lateral geniculate body.
3. medial geniculate body.
4. thalamus.
5. superior thalamic radiation (ascending thalamocortical fibres).
6. genu (lies at the junction between the anterior and posterior limbs, and contains corticonuclear fibres).
7. head of caudate nucleus.
8. anterior limb (between the head of caudate and lentiform nucleus, and contains frontopontine fibres and anterior thalamic radiation).
9. lentiform nucleus (lateral to the internal capsule).
10. acoustic radiation (sublentiform part of internal capsule).
11. frontopontine and corticorubral fibres in the posterior limb of internal capsule.
12. corticospinal fibres in the posterior limb of internal capsule.
13. optic radiation (retrolentiform part of internal capsule).

* The upper limb is represented in the most anterior part of the corticospinal fibres, while the lower limb is in the most posterior part and the trunk is in the middle.

Fig. (352): PARTS OF INTERNAL CAPSULE



1. anterior limb of internal capsule (between the head of caudate and lentiform nucleus).
2. genu (at the junction between the anterior limb and posterior limb).
3. posterior limb (between the thalamus and lentiform nucleus).
4. sublentiform part (below the lentiform nucleus).
5. retrolentiform part (behind the lentiform nucleus).

(a) head of caudate nucleus (in front).

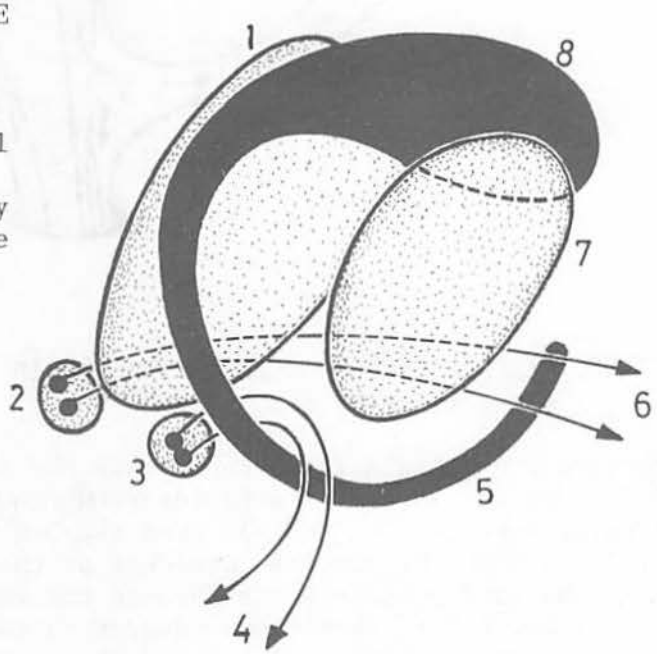
(b) thalamus (medial).

(c) lentiform nucleus (lateral).

(d) superior temporal gyrus.

Fig. (353): SUBLENTIFORM AND RETROLENTIFORM PARTS OF INTERNAL CAPSULE

The sublentiform part is formed by acoustic radiation and lies between the lentiform nucleus above and tail of caudate nucleus below.
The retrolentiform part is formed by optic radiation and its fibres curve around the tail of caudate nucleus behind the lentiform nucleus.



1. thalamus.
2. medial geniculate body.
3. lateral geniculate body.
4. optic radiation.
5. tail of caudate nucleus.
6. acoustic radiation.
7. lentiform nucleus.
8. head of caudate nucleus.

CEREBROSPINAL FLUID
(C.S.F.)

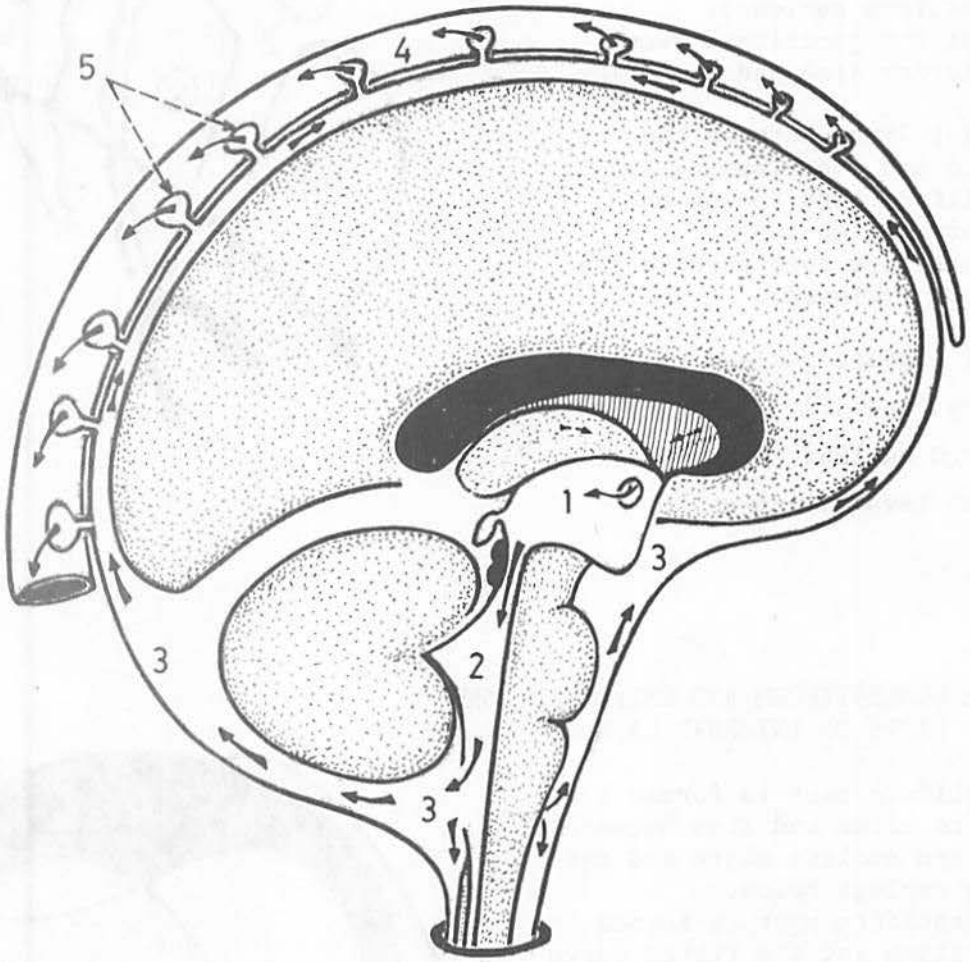


Fig.(354): CIRCULATION OF CEREBROSPINAL FLUID
(sagittal section)

The cerebrospinal fluid is secreted into the ventricles by the choroid plexuses. The C.S.F. in the lateral ventricles passes to the 3rd ventricle through the interventricular foramina (of Monro). From the 3rd ventricle it passes to the 4th ventricle through the cerebral aqueduct of the midbrain. It leaves the 4th ventricle to enter the subarachnoid space through the median and 2 lateral apertures of the 4th ventricle. C.S.F. then flows upwards in the subarachnoid space to be drained into the superior sagittal sinus through the arachnoid granulations.

1. 3rd ventricle.
2. 4th ventricle.
3. subarachnoid space.
4. superior sagittal sinus.
5. arachnoid granulations.

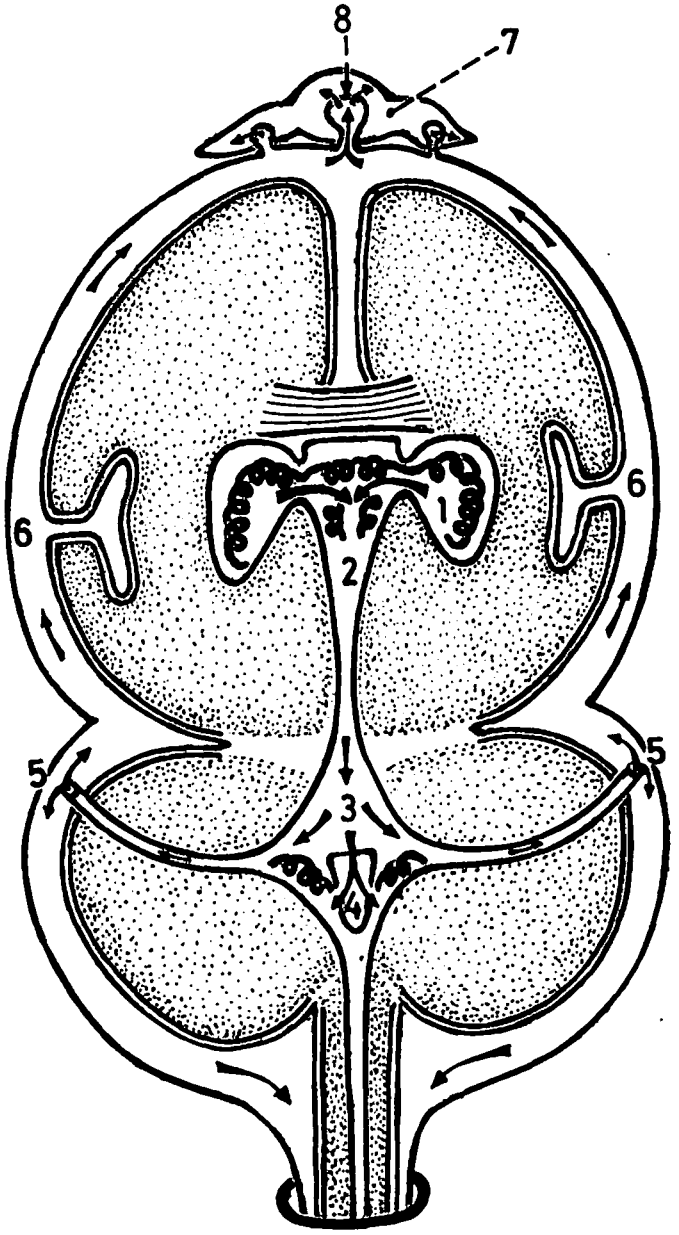


Fig.(355): CIRCULATION OF CEREBROSPINAL FLUID
(coronal section)

1. lateral ventricle containing choroid plexus.
2. 3rd ventricle containing choroid plexuses.
3. 4th ventricle containing choroid plexuses.
4. median aperture of 4th ventricle (of Magendie).
5. lateral aperture of 4th ventricle (of Luschka).
6. subarachnoid space.
7. superior sagittal sinus.
8. arachnoid granulation.

Fig.(356): ARACHNOID GRANULATIONS

These are aggregations of arachnoid villi which protrude into the dural venous sinuses specially the superior sagittal sinus. Through these granulations C.S.F. is drained into the venous blood.

1. emissary vein opening into a venous lacuna.
2. arachnoid granulation projecting into the superior sagittal sinus.
3. superior sagittal sinus.
4. lateral venous lacuna (lateral extension of the superior sagittal sinus).
5. dura mater.
6. subarachnoid space containing C.S.F.
7. falx cerebri.
8. inferior sagittal sinus.

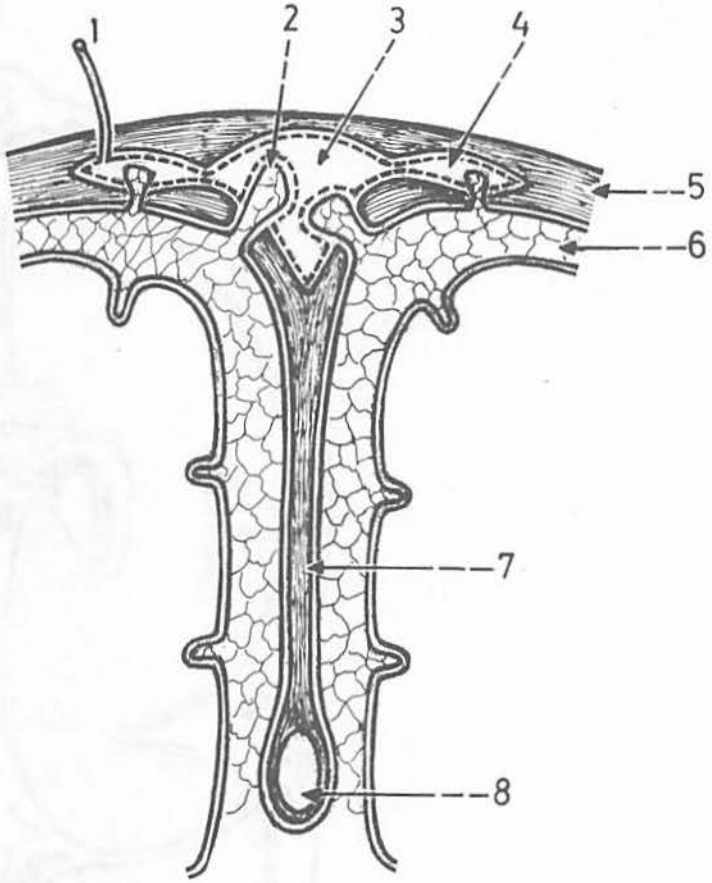


Fig.(357): SUPERIOR SAGITTAL SINUS AND ARACHNOID GRANULATIONS

1. superior sagittal sinus.
2. lateral venous lacunae.
3. arachnoid granulation projecting into a venous lacuna.

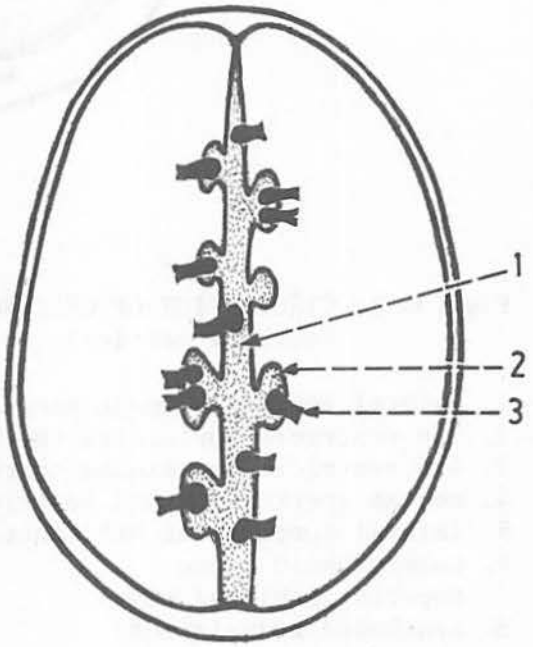


Fig.(358): SUBARACHNOID CISTERNS
(sagittal section)

The subarachnoid cisterns are wide areas of the subarachnoid space. These are the cerebello-medullary cistern, pontine cistern, interpeduncular cistern, cistern of lateral sulcus, supracallosal cistern and cistern of great cerebral vein.

1. interpeduncular cistern.
2. pontine cistern.
3. cerebellomedullary cistern.
4. cistern of great cerebral vein.
5. supracallosal cistern.

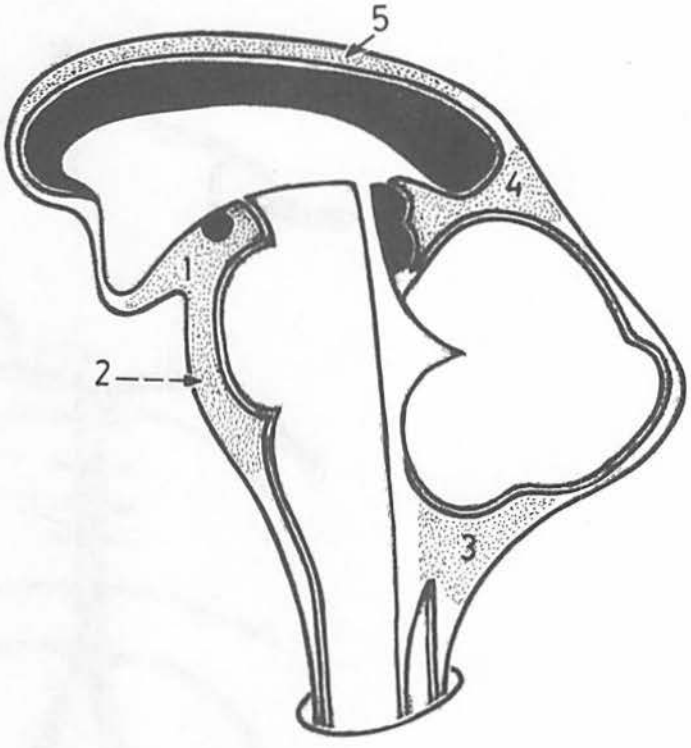
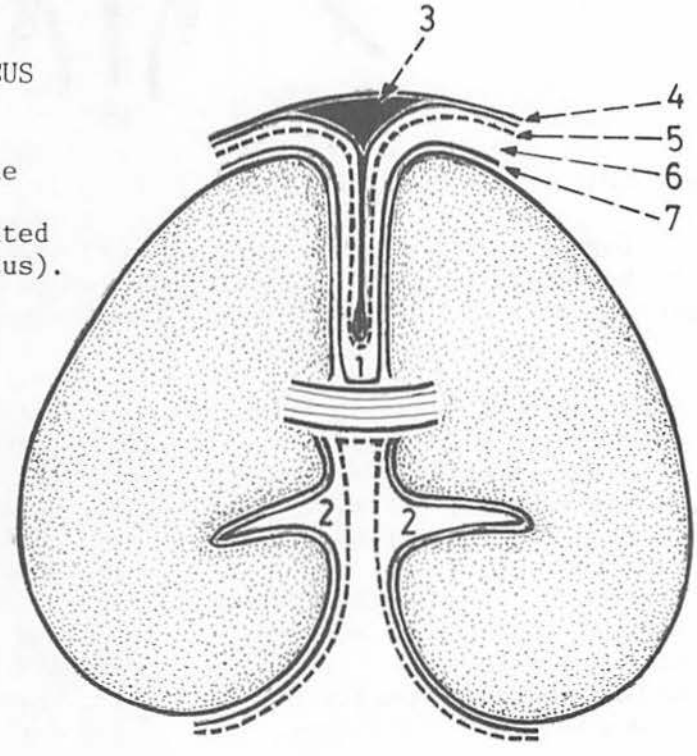


Fig.(359): CISTERN OF LATERAL SULCUS
(coronal section)

1. supracallosal cistern (above the corpus callosum).
2. cistern of lateral sulcus (related to the stem of the lateral sulcus).
3. superior sagittal sinus.
4. dura mater.
5. arachnoid mater.
6. subarachnoid space.
7. pia mater.



ARTERIES OF THE BRAIN

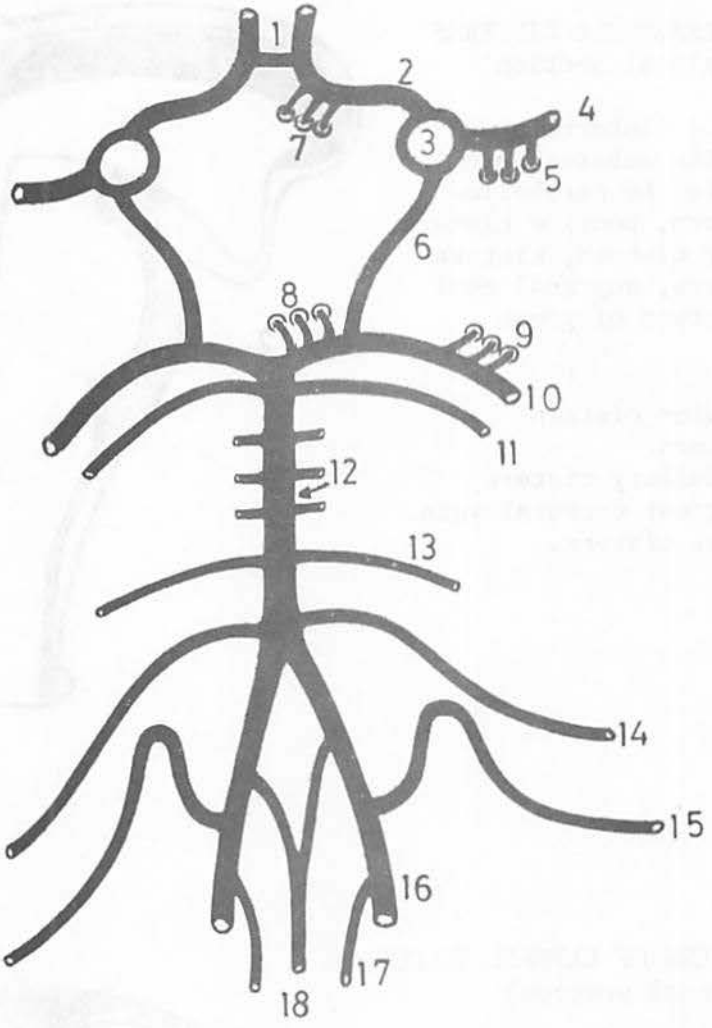


Fig.(360): VERTEBROBASILAR SYSTEM

It is formed by the intracranial parts of the 2 vertebral arteries together with the basilar artery. These arteries supply the brainstem, cerebellum and posterior part of the cerebrum and anastomose with the 2 internal carotid arteries at the circle of Willis.

1. anterior communicating artery.
2. anterior cerebral artery.
3. internal carotid artery.
4. middle cerebral artery.
5. central branches of middle cerebral artery.
6. posterior communicating artery.
7. central branches of anterior cerebral artery.
8. medial central branches of posterior cerebral artery.
9. lateral central branches of posterior cerebral artery.
10. posterior cerebral artery.
11. superior cerebellar artery.
12. basilar artery.
13. labyrinthine artery.
14. anterior inferior cerebellar artery.
15. posterior inferior cerebellar artery.
16. 4th part of vertebral artery.
17. posterior spinal artery.
18. anterior spinal artery.

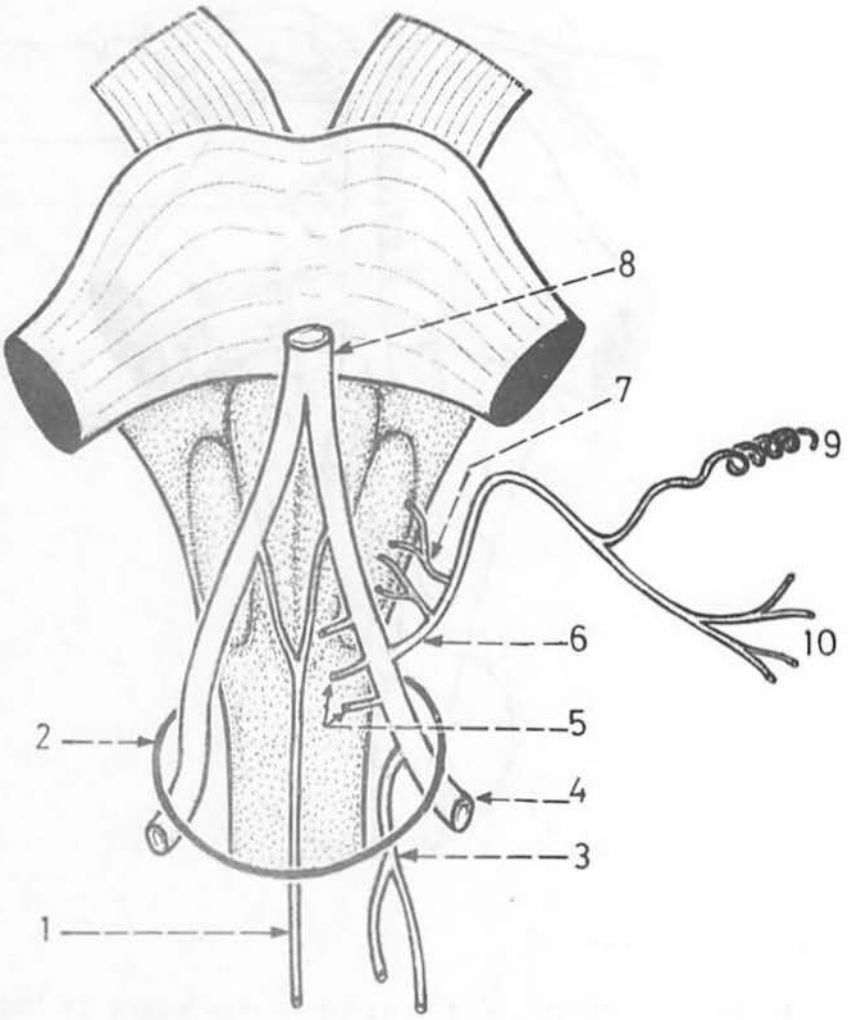


Fig.(361): VERTEBRAL ARTERY

It enters the cranial cavity through the foramen magnum and runs upwards on the ventral surface of the medulla oblongata. It unites with its fellow at the lower border of the pons to form the basilar artery. It gives off the anterior spinal, posterior spinal, posterior inferior cerebellar and medullary branches.

1. anterior spinal artery (formed by the union of right and left branches).
2. foramen magnum.
3. posterior spinal artery.
4. vertebral artery.
5. medullary branches of vertebral artery.
6. posterior inferior cerebellar artery.
7. branches of posterior inferior cerebellar artery to the lateral part of medulla oblongata.
8. basilar artery.
9. branch to the choroid plexus of 4th ventricle.
10. branches to the posterior part of the inferior surface of the cerebellum.

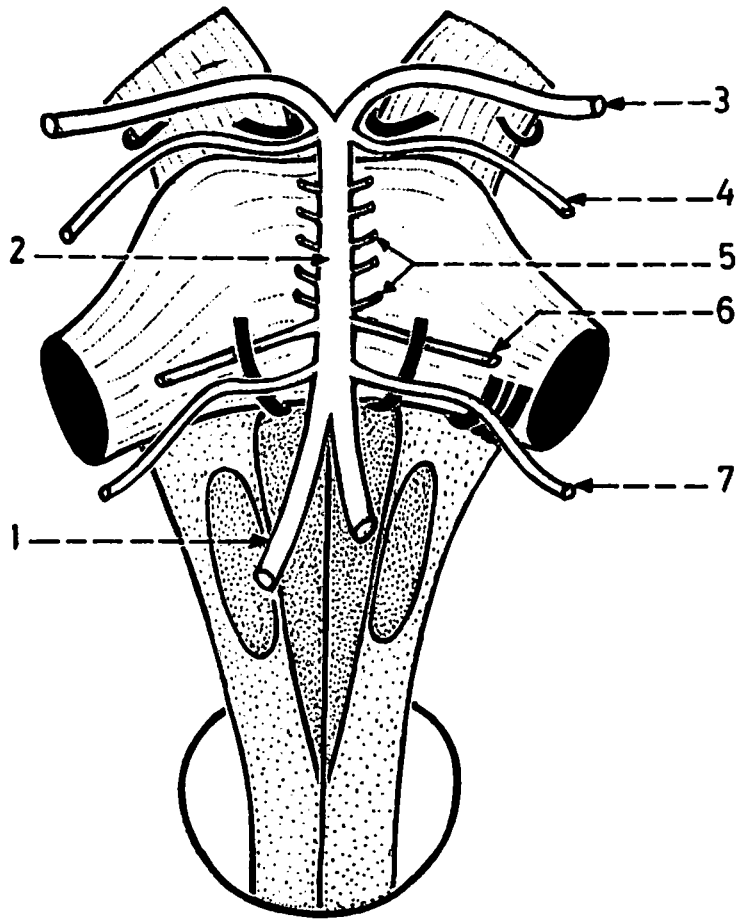


Fig.(362): BASILAR ARTERY

It lies in the basilar sulcus on the front of the pons. It begins at the lower border of the pons by union of the 2 vertebral arteries, and ends at the upper border of the pons by dividing into 2 posterior cerebral arteries. It gives off pontine branches, artery of labyrinth, anterior inferior cerebellar, superior cerebellar and posterior cerebral arteries.

1. vertebral artery.
2. basilar artery.
3. posterior cerebral artery.
4. superior cerebellar artery.
5. pontine branches.
6. artery of the labyrinth (internal auditory artery).
7. anterior inferior cerebellar artery (to the inferior surface of the cerebellum).

* The oculomotor and trochlear nerves lie between the posterior cerebral and superior cerebellar arteries.

* The anterior inferior cerebellar artery runs laterally in front of the 6th, 7th and 8th cranial nerves.

* The posterior inferior cerebellar artery runs among the rootlets of the 9th and 10th cranial nerves on the side of the medulla oblongata.

Fig.(363): CEREBELLAR ARTERIES

These are 3 arteries: superior cerebellar, anterior inferior cerebellar and posterior inferior cerebellar.

1. superior cerebellar artery (from the basilar, and supplies the superior surface).
2. basilar artery.
3. anterior inferior cerebellar artery (from the basilar, and supplies the anterior part of inferior surface).
4. vertebral artery.
5. posterior inferior cerebellar artery (from the vertebral and supplies both the side of the medulla and posterior part of inferior surface of cerebellum).

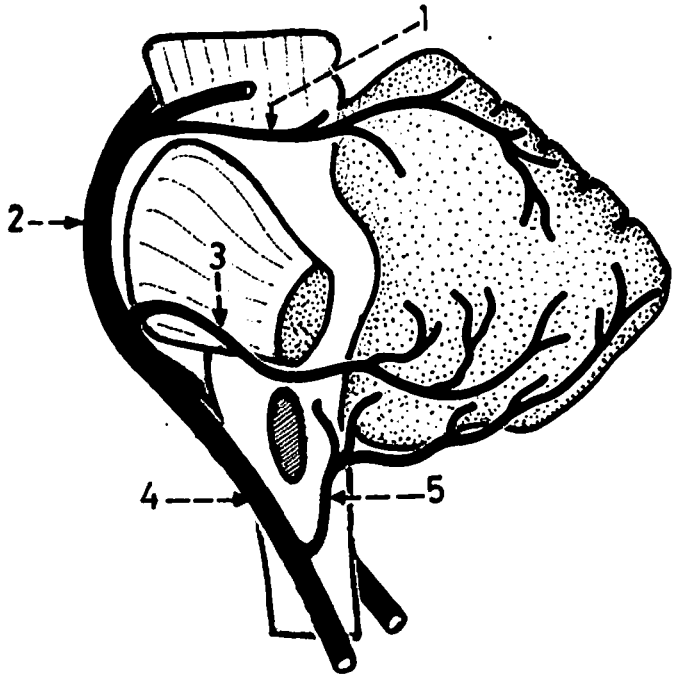


Fig.(364): POSTERIOR CEREBRAL ARTERY ON THE SIDE OF MIDBRAIN

It curves backwards round the lateral aspect of the midbrain above the superior cerebellar artery. Here, the oculomotor and trochlear nerves run forwards between the 2 arteries.

1. medial central branches of posterior cerebral artery.
2. oculomotor nerve.
3. trochlear nerve.
4. posterior cerebral artery.
5. superior cerebellar artery.
6. lateral central branches of posterior cerebral artery (to the midbrain).

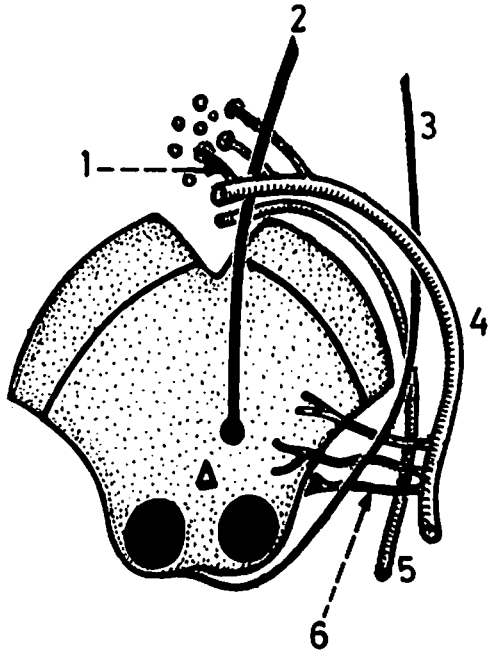


Fig.(365): POSTERIOR CEREBRAL ARTERY
ON THE INFERIOR SURFACE
OF CEREBRAL HEMISPHERE

The artery gives off cortical branches to the tentorial surface of the brain except the temporal pole. These branches extend laterally to supply the lowermost 1 finger breadth of the superolateral surface of the hemisphere.

1. posterior cerebral artery.
2. medial central branches (pierce the posterior perforated substance).
3. lateral central branches (to the midbrain).
4. cortical branches.
5. temporal pole.

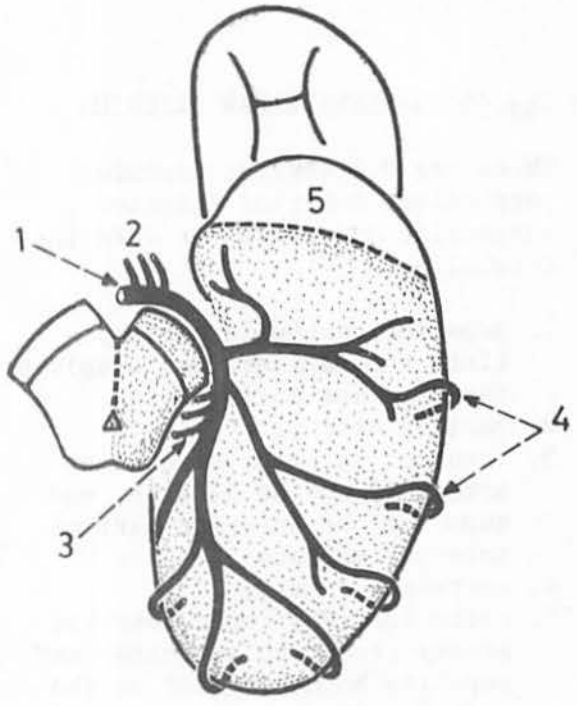
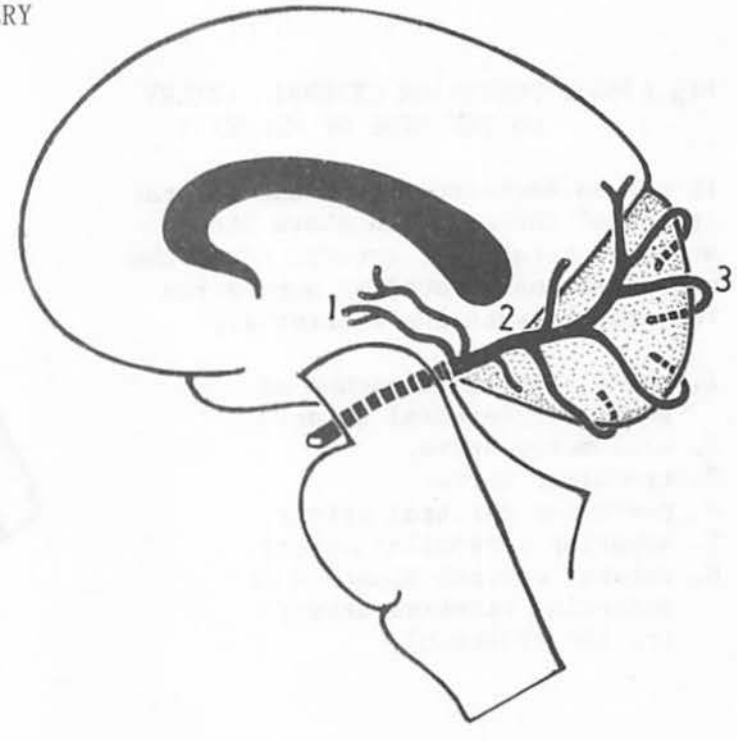


Fig.(366): POSTERIOR CEREBRAL ARTERY
ON THE MEDIAL SURFACE
OF CEREBRAL HEMISPHERE

The artery runs in the calcarine fissure. Its cortical branches ramify on the occipital lobe and gives off choroidal branches to the 3rd and lateral ventricles.

1. choroidal arteries to the 3rd and lateral ventricles.
2. posterior cerebral artery in the calcarine fissure.
3. cortical branches to the occipital lobe.



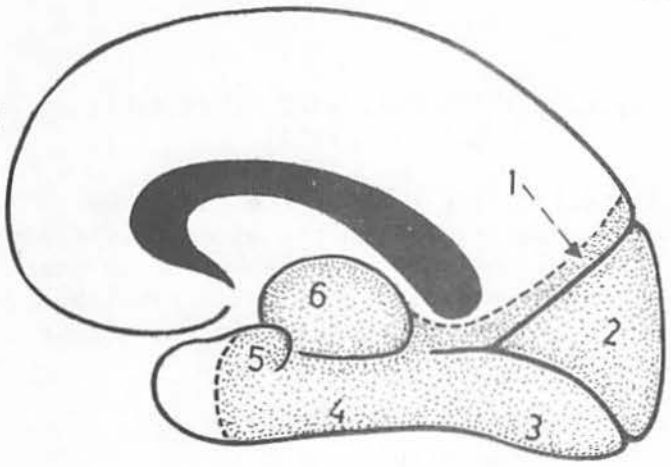


Fig.(367): AREAS ON THE MEDIAL SURFACE SUPPLIED BY POSTERIOR CEREBRAL ARTERY

1. posterior part of precuneus adjacent to the parieto-occipital sulcus.
2. cuneus.
3. lingual gyrus.
4. parahippocampal gyrus.
5. uncus.
6. thalamus.

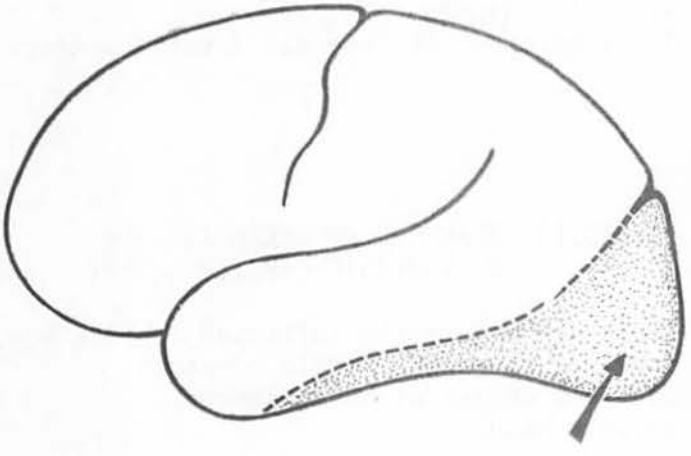


Fig.(368): AREAS ON THE SUPEROLATERAL SURFACE SUPPLIED BY POSTERIOR CEREBRAL ARTERY

These areas are the occipital lobe and a finger breadth of the temporal lobe close to the inferolateral border, except the temporal pole which is supplied by the middle cerebral artery.

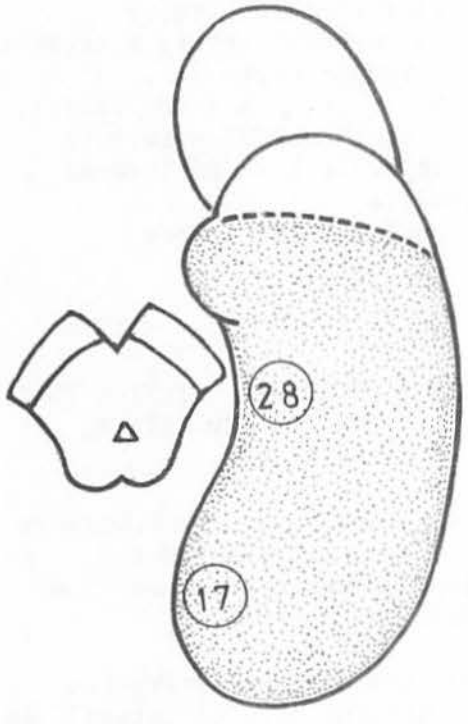
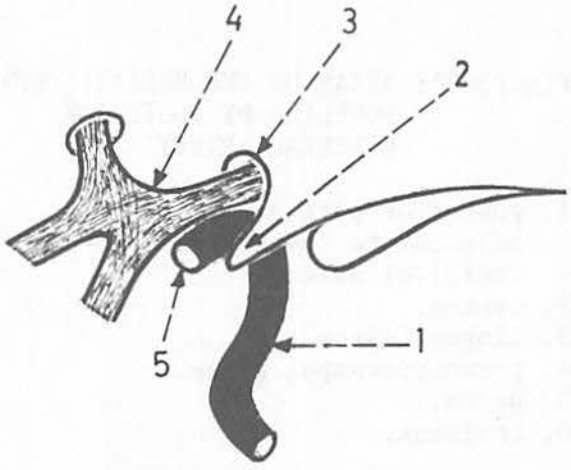


Fig.(369): AREAS ON THE INFERIOR SURFACE SUPPLIED BY POSTERIOR CEREBRAL ARTERY

These areas occupy the whole tentorial surface except the temporal pole. They include areas of vision (area 17) and smell (area 28).

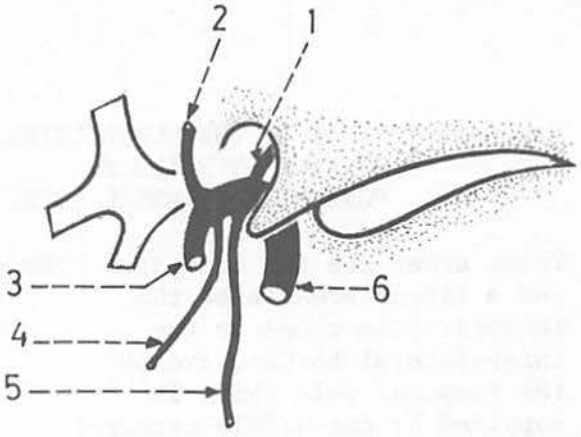
Fig.(370): CEREBRAL PART OF INTERNAL CAROTID ARTERY



It pierces the roof of the cavernous sinus just medial to the anterior clinoid process, and then runs backwards to just below the anterior perforated substance where it ends by dividing into anterior and middle cerebral arteries.

1. internal carotid artery (in the cavernous sinus).
2. anterior clinoid process.
3. optic canal.
4. optic chiasma.
5. termination of internal carotid artery.

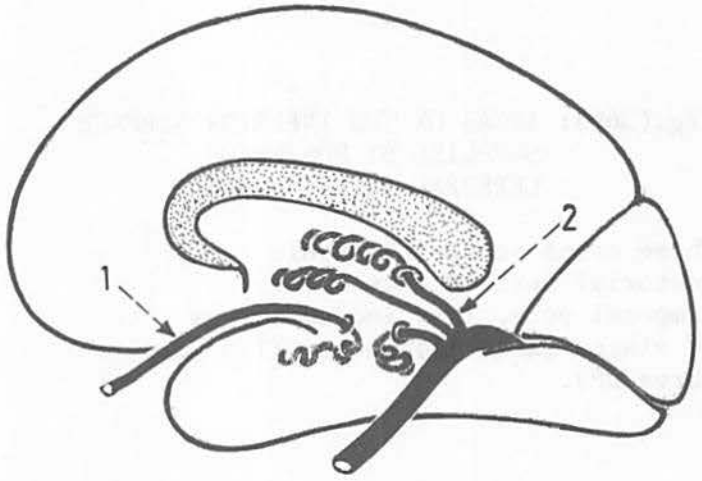
Fig.(371): BRANCHES OF CEREBRAL PART OF INTERNAL CAROTID ARTERY



These are mainly the following: ophthalmic, anterior cerebral, middle cerebral, anterior choroidal and posterior communicating.

1. ophthalmic artery.
2. anterior cerebral artery.
3. middle cerebral artery (larger than the anterior cerebral).
4. posterior communicating artery.
5. anterior choroidal artery (to the inferior horn of lateral ventricle).
6. internal carotid artery.

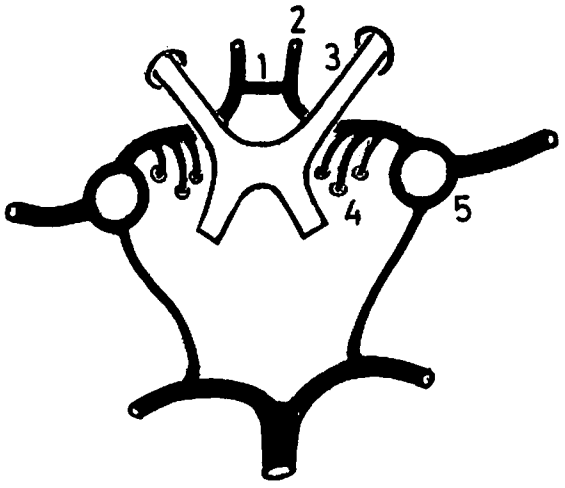
Fig.(372): CHOROIDAL ARTERIES TO THE 3rd AND LATERAL VENTRICLES



These are anterior choroidal artery from the internal carotid and posterior choroidal arteries from the posterior cerebral.

1. anterior choroidal artery (to the inferior horn of lateral ventricle).
2. posterior choroidal arteries(to the 3rd and lateral ventricles).

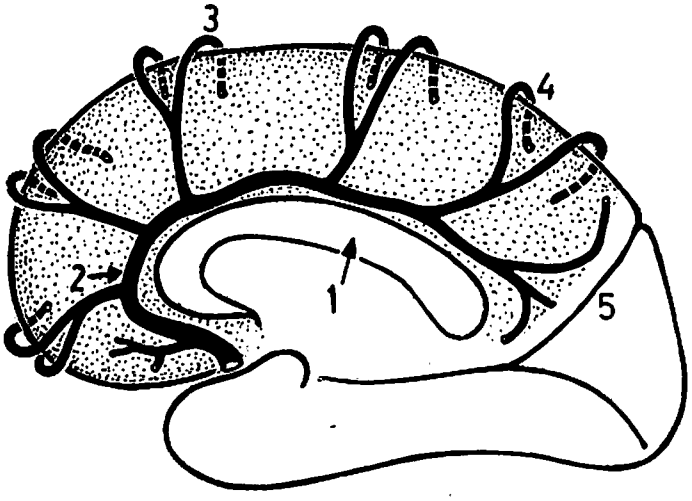
Fig.(373): ANTERIOR CEREBRAL ARTERY ON THE BASE OF THE BRAIN



It arises from the internal carotid artery and runs anteromedially above the optic chiasma, and then turns upwards to gain the medial surface of the cerebral hemisphere. It is connected with its fellow by the anterior communicating artery, and gives near its origin a number of central branches which pierce the anterior perforated substance.

1. anterior communicating artery.
2. anterior cerebral artery.
3. optic nerve joining the optic chiasma.
4. central branches of anterior cerebral artery.
5. internal carotid artery.

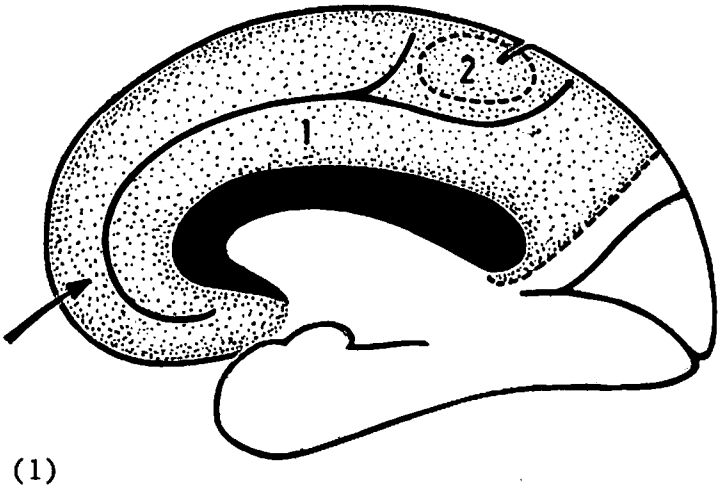
Fig.(374): ANTERIOR CEREBRAL ARTERY ON THE MEDIAL SURFACE OF CEREBRAL HEMISPHERE



It curves round the genu of the corpus callosum and then continues backwards on the upper surface of the trunk of the corpus callosum as far as the splenium where it ends by anastomosing with the posterior cerebral artery.

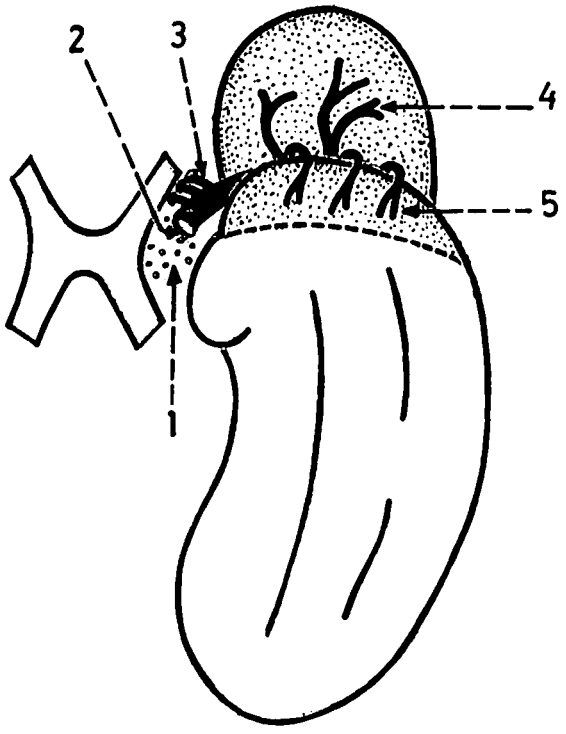
1. corpus callosum.
2. anterior cerebral artery on the medial surface of the cerebral hemisphere.
3. cortical branches to the frontal lobe.
4. cortical branches to the parietal lobe.
5. parieto-occipital sulcus.

Fig.(375): AREAS SUPPLIED BY THE ANTERIOR CEREBRAL ARTERY



These areas are the cingulate gyrus (1) and the paracentral lobule (2). It also supplies a finger breadth on the superolateral surface close to the superomedial border.

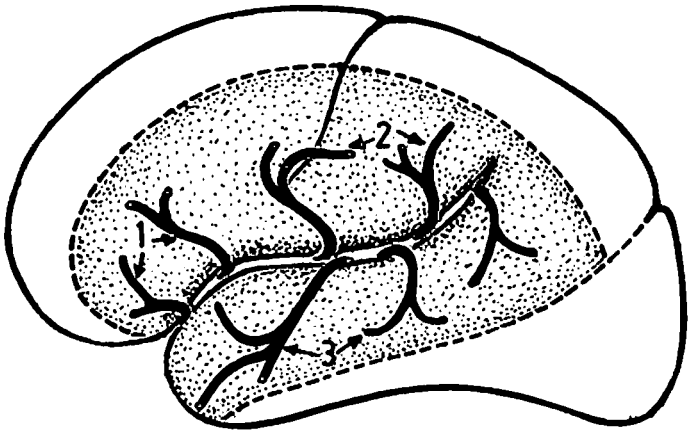
Fig.(376): MIDDLE CEREBRAL ARTERY IN THE STEM OF THE LATERAL SULCUS



It arises from the internal carotid artery and runs laterally in the stem of the lateral sulcus to enter the insula. Near its origin it gives off central branches which pierce the anterior perforated substance.

1. anterior perforated substance.
2. middle cerebral artery.
3. central branches (striate arteries).
4. cortical branches to the orbital surface.
5. cortical branches to the temporal pole.

Fig.(377): MIDDLE CEREBRAL ARTERY ON THE SUPEROLATERAL SURFACE OF CEREBRAL HEMISPHERE

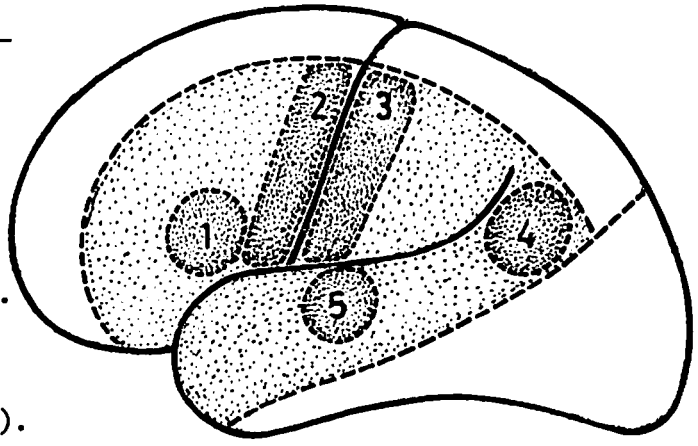


It runs deeply on the surface of the insula, and gives off cortical branches which emerge between the lips of the lateral sulcus.

1. cortical branches to the frontal lobe.
2. cortical branches to the parietal lobe.
3. cortical branches to the temporal lobe.

* Note that the middle cerebral artery does not reach either the superomedial border or the inferolateral border of the hemisphere.

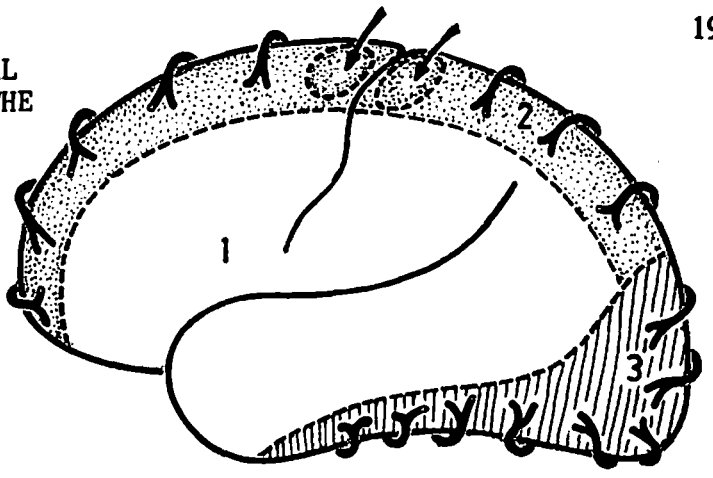
Fig.(378): AREAS SUPPLIED BY THE MIDDLE CEREBRAL ARTERY



It supplies important cortical areas.

1. Broca's area (areas 44,45).
2. somatic motor area (area 4).
3. somatic sensory area (areas 3,1,2).
4. speech area of Wernicke (area 39).
5. auditory area (areas 41,42).

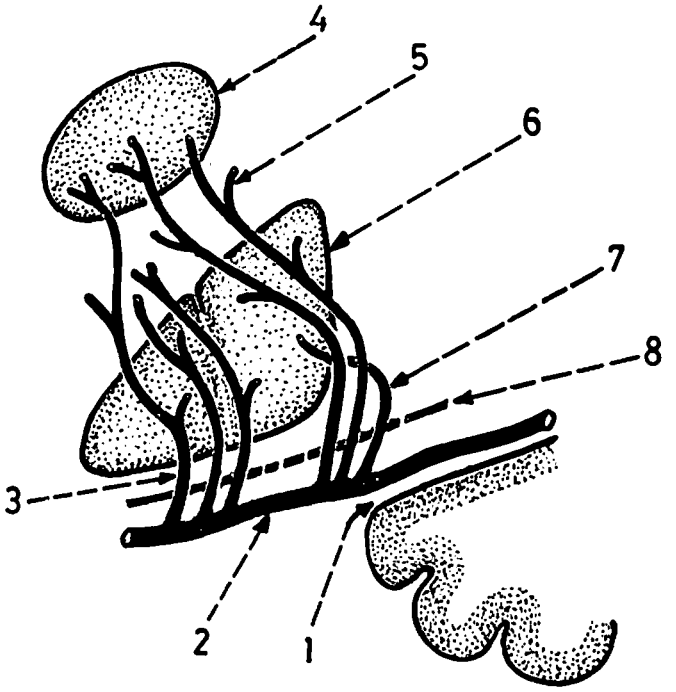
Fig.(379): AREAS ON THE SUPEROLATERAL SURFACE NOT SUPPLIED BY THE MIDDLE CEREBRAL ARTERY



These areas are occipital lobe, a finger breadth close to the superomedial border and a finger breadth close to the inferolateral border.

1. area supplied by middle cerebral artery.
2. area supplied by anterior cerebral artery (the arrows point to the leg area).
3. area supplied by posterior cerebral artery.

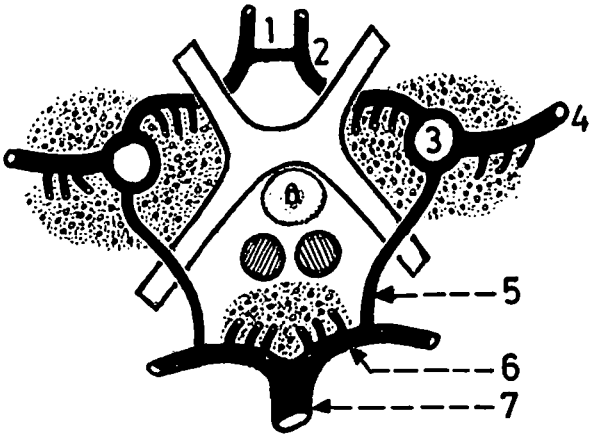
Fig.(380): STRIATE ARTERIES OF THE MIDDLE CEREBRAL



These are central branches which pierce the anterior perforated substance to supply the corpus striatum. They are medial striate and lateral striate groups.

1. stem of lateral sulcus.
2. middle cerebral artery.
3. medial striate arteries.
4. caudate nucleus.
5. arteries traversing the internal capsule.
6. lentiform nucleus.
7. lateral striate arteries.
8. anterior perforated substance.

Fig.(381): CIRCULUS ARTERIOSUS (CIRCLE OF WILLIS)



It is an anastomosis between the 2 internal carotid arteries and the 2 posterior cerebral arteries. It lies in the interpeduncular fossa.

1. anterior communicating artery.
2. anterior cerebral artery.
3. internal carotid artery.
4. middle cerebral artery.
5. posterior communicating artery.
6. posterior cerebral artery.
7. basilar artery.

* This circle is formed by the anterior communicating, posterior communicating, anterior cerebral and posterior cerebral arteries.

VEINS OF THE BRAIN

Fig.(382): SUPERIOR CEREBRAL VEINS

These are external cerebral veins which drain the superolateral surface of the cerebral hemisphere. They run upwards and forwards to open into the superior sagittal sinus.

1. superior sagittal sinus.
2. superior cerebral veins on the superolateral surface.

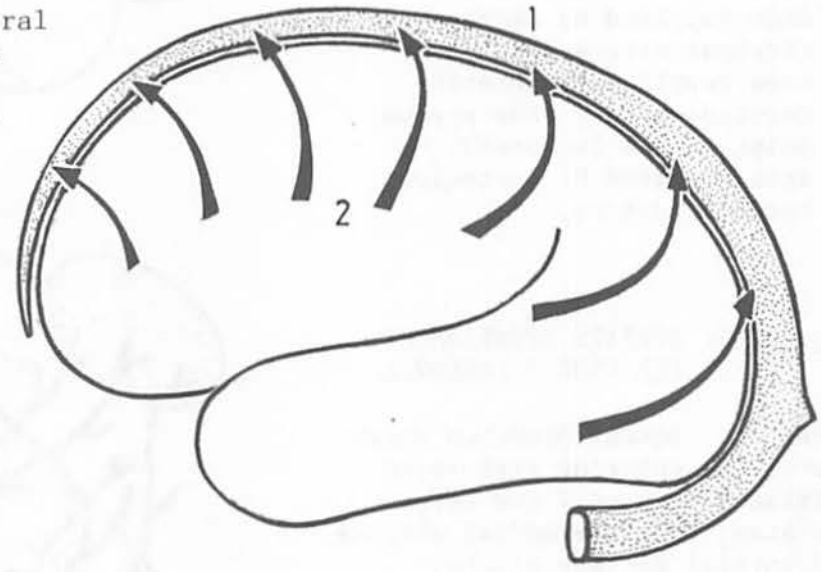
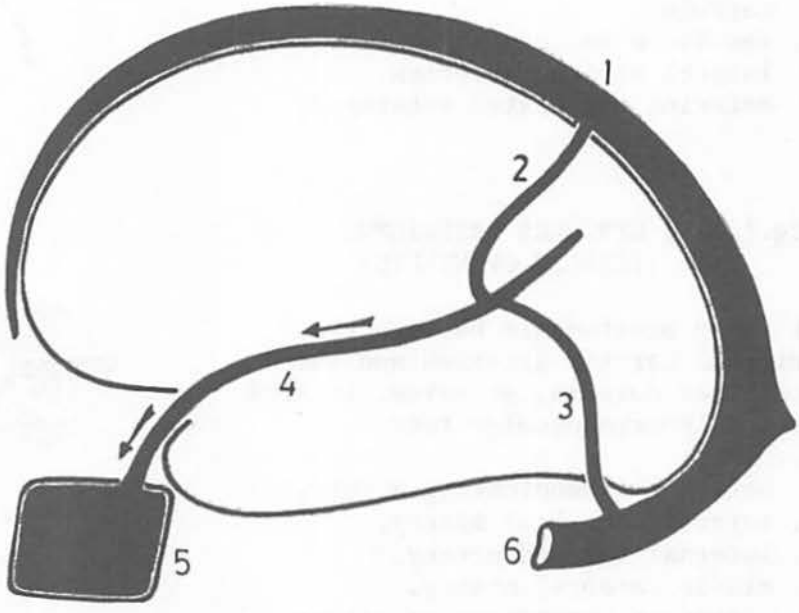


Fig.(383): SUPERFICIAL MIDDLE CEREBRAL VEIN

It lies on the superolateral surface between the lips of the posterior ramus of lateral sulcus. It communicates with the superior sagittal sinus by the superior anastomotic vein and with the transverse sinus by the inferior anastomotic vein. It opens into the cavernous sinus.

1. superior sagittal sinus.
2. superior anastomotic vein.
3. inferior anastomotic vein.
4. superficial middle cerebral vein.
5. cavernous sinus.
6. transverse sinus.



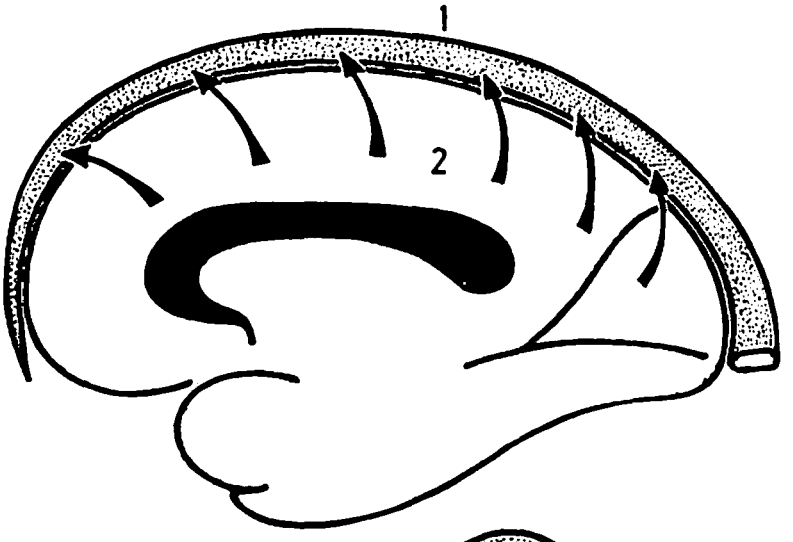


Fig.(384): EXTERNAL CEREBRAL VEINS ON THE MEDIAL SURFACE OF CEREBRAL HEMISPHERE

They drain into the superior sagittal sinus.

1. superior sagittal sinus.
2. medial surface of cerebral hemisphere.

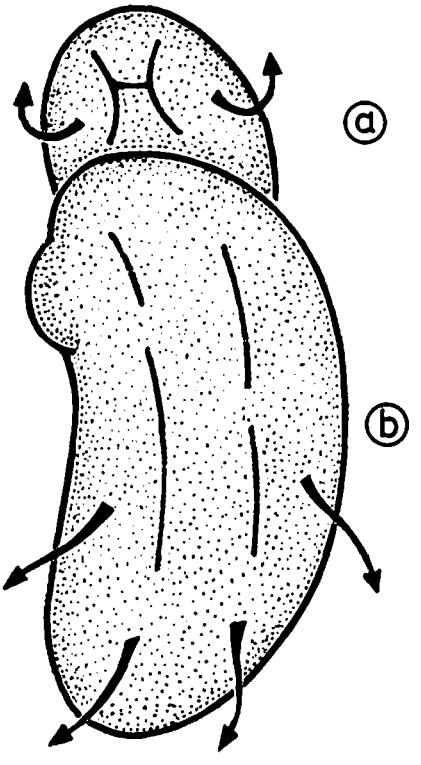


Fig.(385): INFERIOR CEREBRAL VEINS

They drain the inferior surface of the cerebral hemisphere.

(a) veins of the orbital surface join the superior cerebral veins and through them to the superior sagittal sinus.

(b) veins of tentorial surface drain into the basal vein as well as into neighbouring dural sinuses (cavernous, superior petrosal and transverse).

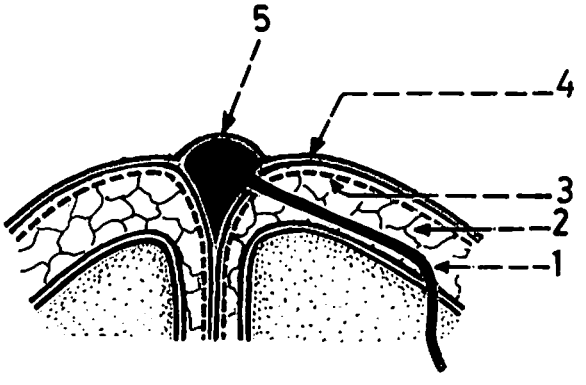
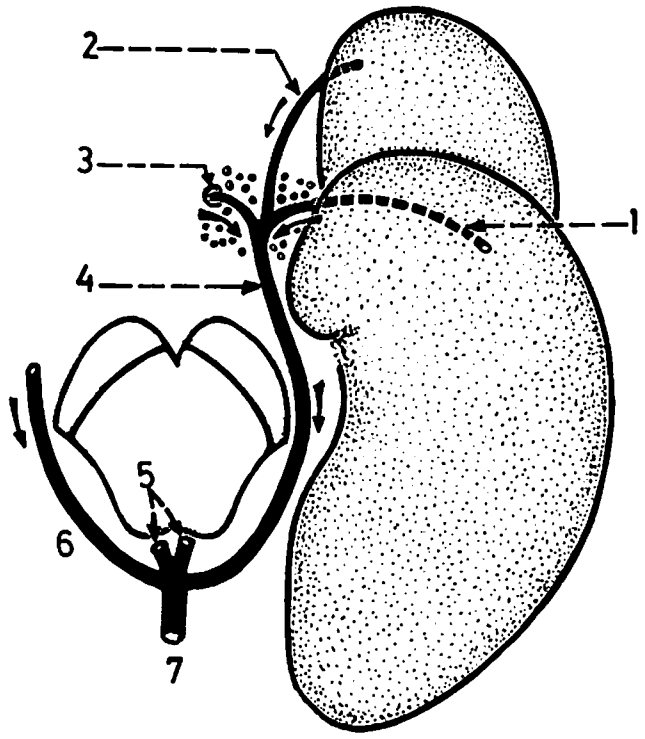


Fig.(386): TERMINATION OF THE EXTERNAL CEREBRAL VEINS INTO THE SUPERIOR SAGITTAL SINUS

As these veins leave the surface of the brain they traverse the subarachnoid space and the subdural space to open into the superior sagittal sinus.

1. superior cerebral vein.
2. subarachnoid space.
3. arachnoid mater.
4. dura mater.
5. superior sagittal sinus.

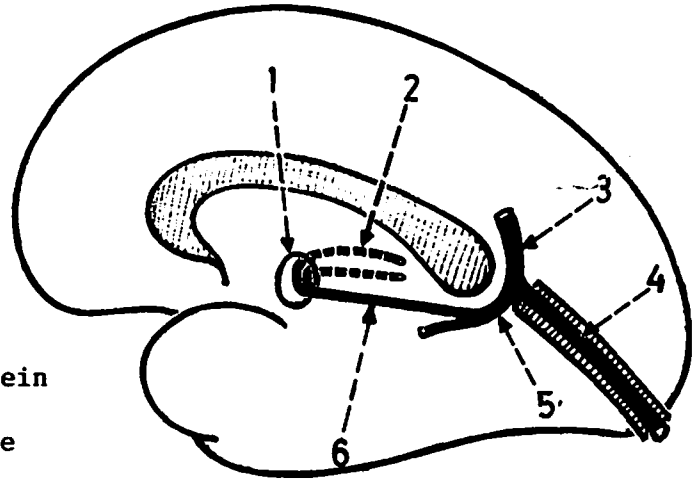
Fig.(387): BASAL VEINS



There is one basal vein on each side of the midbrain. Each vein begins at the anterior perforated substance by union of the anterior cerebral vein, deep middle cerebral vein and the striate vein from the corpus striatum. It runs backwards on the side of midbrain to end in the great cerebral vein.

1. deep middle cerebral vein (on the surface of the insula).
2. anterior cerebral vein.
3. striate vein (drains the corpus striatum and emerges through the anterior perforated substance).
4. basal vein.
5. the 2 internal cerebral veins.
6. basal vein of the opposite side.
7. great cerebral vein (formed by the union of the 2 internal cerebral veins).

Fig.(388): INTERNAL CEREBRAL VEINS



The interior of each cerebral hemisphere is drained by an internal cerebral vein which begins at the interventricular foramen by union of the thalamostriate vein and choroid vein. The internal cerebral vein runs backwards in the tela choroidea of the roof of the 3rd ventricle to join its fellow of the opposite side at the splenium to form the great cerebral vein.

1. interventricular foramen.
2. thalamostriate vein and choroid vein (inside the lateral ventricle).
3. inferior sagittal sinus (joins the great cerebral vein to form the straight sinus).
4. straight sinus (in the tentorium cerebelli).
5. great cerebral vein (formed by union of the 2 internal cerebral veins).
6. internal cerebral vein (in the roof of 3rd ventricle).

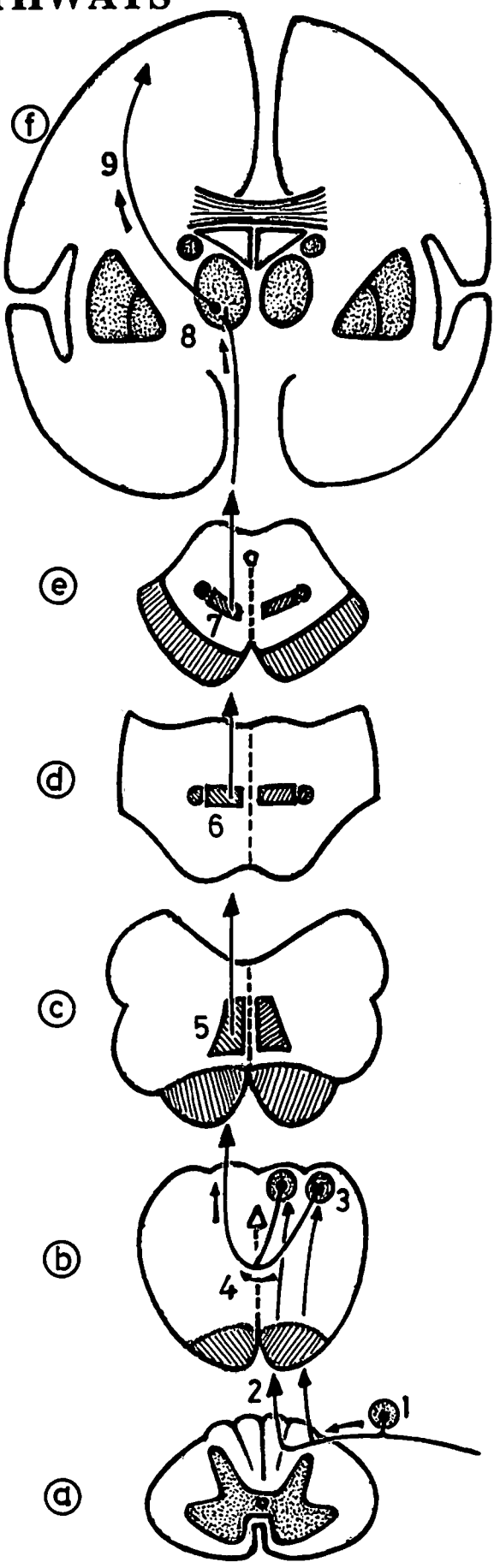
Fig.(389): PATHWAY OF PROPRIOCEPTION AND FINE TOUCH FROM THE BODY (BELOW THE HEAD) TO THE CEREBRUM

This pathway consists of the following: dorsal root ganglia and their central processes forming the gracile and cuneate tracts, gracile and cuneate nuclei and their axons forming the medial lemniscus, and the posterolateral ventral nucleus of thalamus and its axons formimg the thalamocortical fibres which end in the postcentral gyrus (areas 3,1,2).

a. spinal cord.
b. closed medulla.
c. open medulla.
d. pons.
e. midbrain.
f. cerebral hemisphere.

1. dorsal root ganglion.
2. gracile and cuneate tracts.
3. gracile and cuneate nuclei.
4. decussation of internal arcuate fibres forming the sensory decussation.
5. medial lemniscus in the open medulla.
6. medial lemniscus in the pons.
7. medial lemniscus in the midbrain.
8. posterolateral ventral nucleus of thalamus.
9. thalamocortical fibres to the postcentral gyrus.

* This pathway consists of 3 neurons:
N 1: dorsal root ganglion.
N 2: gracile and cuneate nuclei.
N 3: posterolateral ventral nucleus of thalamus.



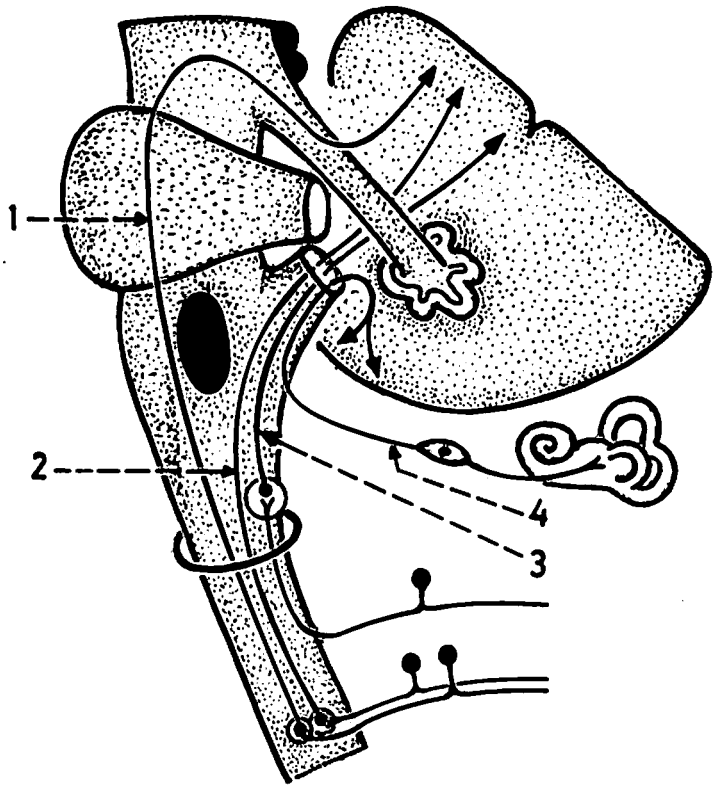


Fig.(390): PATHWAYS OF PROPRIOCEPTION FROM THE BODY TO THE CEREBELLUM

These pathways are the following:

* posterior spinocerebellar tract: arises from Clarke's nucleus.
* anterior spinocerebellar tract: arises from cells at the base of the posterior horn.
* cuneocerebellar tract: arises from the accessory cuneate nucleus.
* vestibulocerebellar tract: arises from the vestibular ganglion as well as from the vestibular nuclei.

1. anterior spinocerebellar tract (enters the cerebellum through the superior cerebellar peduncle).
2. posterior spinocerebellar tract (enters the cerebellum through the inferior cerebellar peduncle).
3. cuneocerebellar tract (enters the cerebellum through the inferior cerebellar peduncle).
4. vestibulocerebellar tract (enters the cerebellum through the inferior cerebellar peduncle).

* The pathways to the cerebellum consist of 2 neurons but those to the cerebrum consist of 3 neurons.

* The tracts from the spinal cord to the cerebellum end in the ipsilateral cerebellar hemisphere, while tracts to the cerebrum end in the contralateral cerebral hemisphere.

Fig.(391): PATHWAY OF PAIN AND TEMPERATURE SENSATIONS FROM THE BODY (BELOW THE HEAD) TO THE CEREBRUM

This pathway consists of the following: dorsal root ganglia and their central processes forming the dorsolateral tract of Lissauer, substantia gelatinosa and its axons forming the lateral spinothalamic tract,and the posterolateral ventral nucleus of thalamus and its axons forming the thalamocortical fibres which end in the postcentral gyrus (areas 3,1,2).

a. spinal cord.
b. closed medulla.
c. open medulla.
d. pons.
e. midbrain.
f. cerebral hemisphere.

1. dorsal root ganglion.
2. substantia gelatinosa.
3. decussation of lateral spinothalamic tracts in the white commissure of spinal cord.
4. lateral spinothalamic tract.
5. spinal lemniscus (upward continuation of lateral spinothalamic tract) in closed medulla.
6. spinal lemniscus in the open medulla.
7. spinal lemniscus in the pons.
8. spinal lemniscus in the midbrain.
9. posterolateral ventral nucleus of thalamus.
10. thalamocortical fibres to the postcentral gyrus.

* This pathway consists of 3 neurons:
N 1: dorsal root ganglion.
N 2: substantia gelatinosa.
N 3: posterolateral ventral nucleus of thalamus.

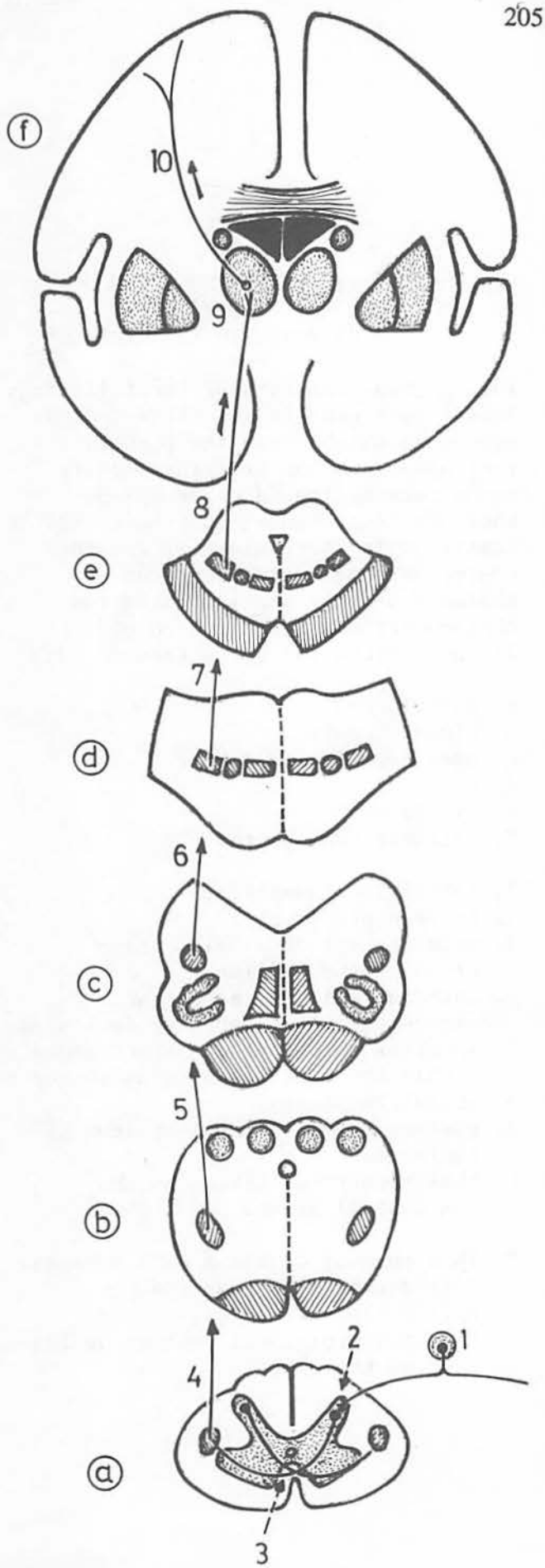


Fig.(392): PATHWAY OF CRUDE TOUCH FROM THE BODY (BELOW THE HEAD) TO THE CEREBRUM

This pathway consists of the following: dorsal root ganglia and their central processes which enter the posterior funiculus, nucleus proprius and its axons forming the anterior spinothalamic tract which joins the spinal lemniscus in the brainstem, and the posterolateral ventral nucleus of thalamus and its axons forming the thalamocortical fibres which end in the postcentral gyrus (areas 3,1,2).

a. spinal cord.
b. closed medulla.
c. open medulla.
d. pons.
e. midbrain.
f. cerebral hemisphere.

1. dorsal root ganglion.
2. nucleus proprius.
3. anterior spinothalamic fibres crossing the midline.
4. anterior spinothalamic tract ascending in the anterior funiculus.
5. anterior spinothalamic tract ascending within the spinal lemniscus in the medulla.
6. spinal lemniscus.
7. posterolateral ventral nucleus of thalamus.
8. thalamocortical fibres to the postcentral gyrus.

* This pathway consists of 3 neurons:
N 1: dorsal root ganglion.
N 2: nucleus proprius.
N 3. posterolateral ventral nucleus of thalamus.

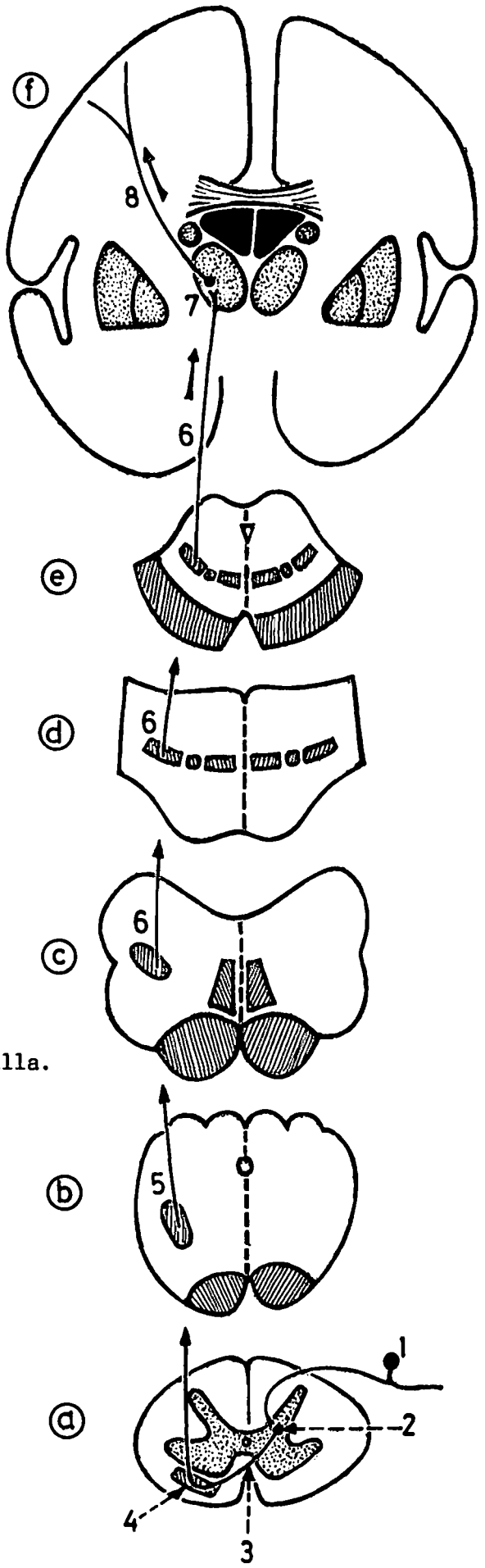


Fig.(393): SENSORY PATHWAYS FROM THE HEAD TO THE CEREBRUM

General sensations from the head are conveyed to the brainstem through the trigeminal nerve. These fibres relay in the sensory nuclei of the trigeminal nerve which give rise to the fibres of the trigeminal lemniscus. This lemniscus ends in the postero-medial ventral nucleus of thalamus. From the thalamus thalamocortical fibres pass to the postcentral gyrus (areas 3,1,2).

a. closed medulla.
b. open medulla.
c. pons.
d. midbrain.
e. cerebral hemisphere.

1. trigeminal ganglion.
2. main sensory nucleus of trigeminal nerve (for touch).
3. mesencephalic nucleus of trigeminal nerve (for proprioception).
4. spinal nucleus of trigeminal nerve (for pain and temperature).
5. spinal tract of trigeminal nerve.
6. spinal nucleus of trigeminal nerve in the closed medulla.
7. trigeminal lemniscus.
8. posteromedial ventral nucleus of thalamus.
9. thalamocortical fibres to the postcentral gyrus.

* This pathway consists of 3 neurons:
N 1: trigeminal ganglion.
N 2: sensory nuclei of trigeminal nerve.
N 3: posteromedial ventral nucleus of thalamus.

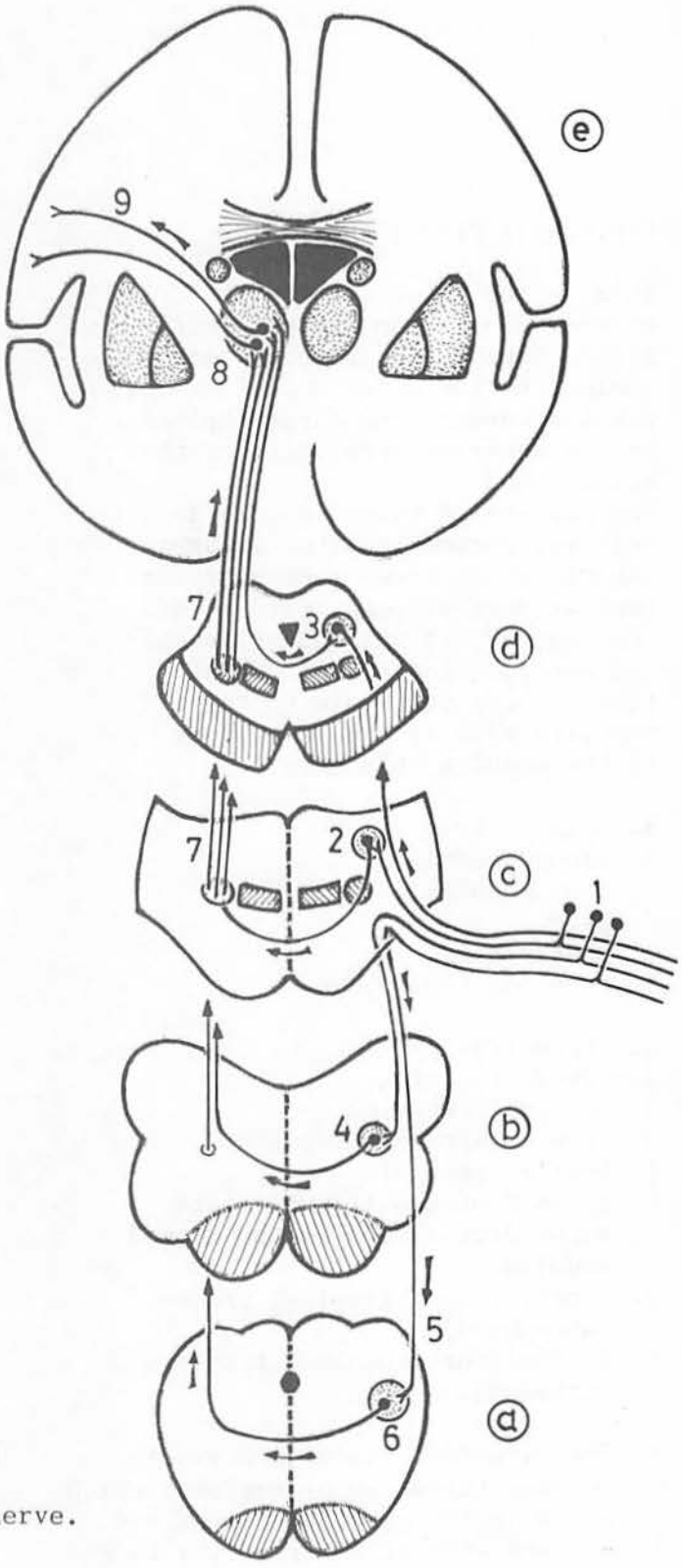


Fig.(394): PYRAMIDAL TRACT

This is the motor tract which arises mainly from the precentral gyrus. Its fibres are both corticonuclear to the motor nuclei of the cranial nerves, and corticospinal to the anterior horn cells of the spinal cord.
The pathway of this tract is as follows: corona radiata, internal capsule, crus cerebri of midbrain, basilar part of pons, pyramid of medulla, and spinal cord (lateral and anterior funiculi). 85% of these fibres decussate to the opposite side in the lower part of the medulla oblongata.

a. spinal cord.
b. closed medulla.
c. open medulla.
d. pons.
e. midbrain.
f. cerebral hemisphere.

1. precentral gyrus.
2. corona radiata.
3. internal capsule.
4. crus cerebri of midbrain.
5. basilar part of pons.
6. pyramid of medulla oblongata.
7. motor decussation in the closed medulla.
8. anterior corticospinal tract (uncrossed).
9. lateral corticospinal tract (crossed).

* The pyramidal fibres are single neurons (upper motor neurons) which arise in the cerebral cortex and descend without interruption to end on the motor nuclei of cranial nerves (corticonuclear) or on the anterior horn cells of spinal cord (corticospinal).

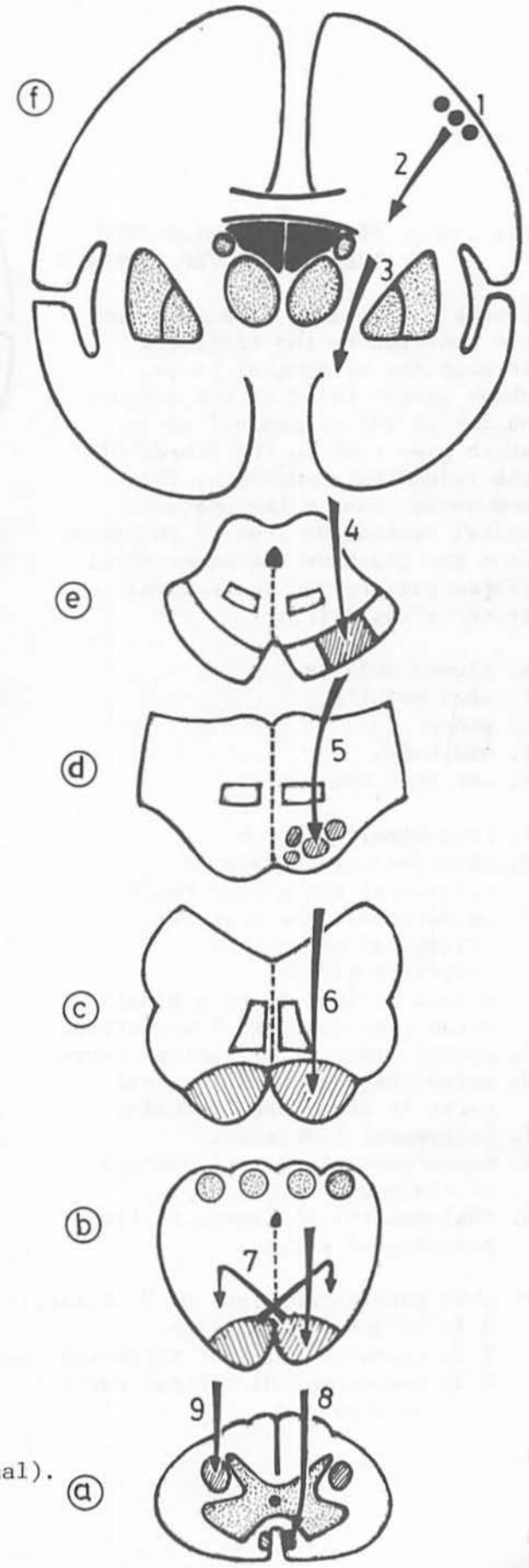


Fig.(395): EXTRAPYRAMIDAL CENTRES

The extrapyramidal system consists of centres and tracts. The extrapyramidal centres are mainly: premotor area of the frontal cortex (area 6), corpus striatum, subthalamic nucleus, red nucleus and substantia nigra in the midbrain, reticular nuclei in the whole brainstem and inferior olivary nucleus in the medulla.

a. spinal cord.
b. closed medulla.
c. open medulla.
d. pons.
e. midbrain.
f. cerebral hemisphere.

1. premotor area of frontal cortex (area 6).
2. caudate nucleus (part of corpus striatum).
3. thalamus.
4. subthalamic nucleus.
5. lentiform nucleus (part of corpus striatum).
6. reticular nuclei of midbrain.
7. red nucleus.
8. substantia nigra.
9. reticular nuclei in the pons.
10. reticular nuclei in open medulla.
11. inferior olivary nucleus.
12. reticular nuclei in the closed medulla.
13. rubrospinal and reticulospinal tracts (extrapyramidal).
14. olivospinal tract (extrapyramidal).

* In contrast to the pyramidal system which is monosynaptic (one synapse), the extrapyramidal system is polysynaptic.

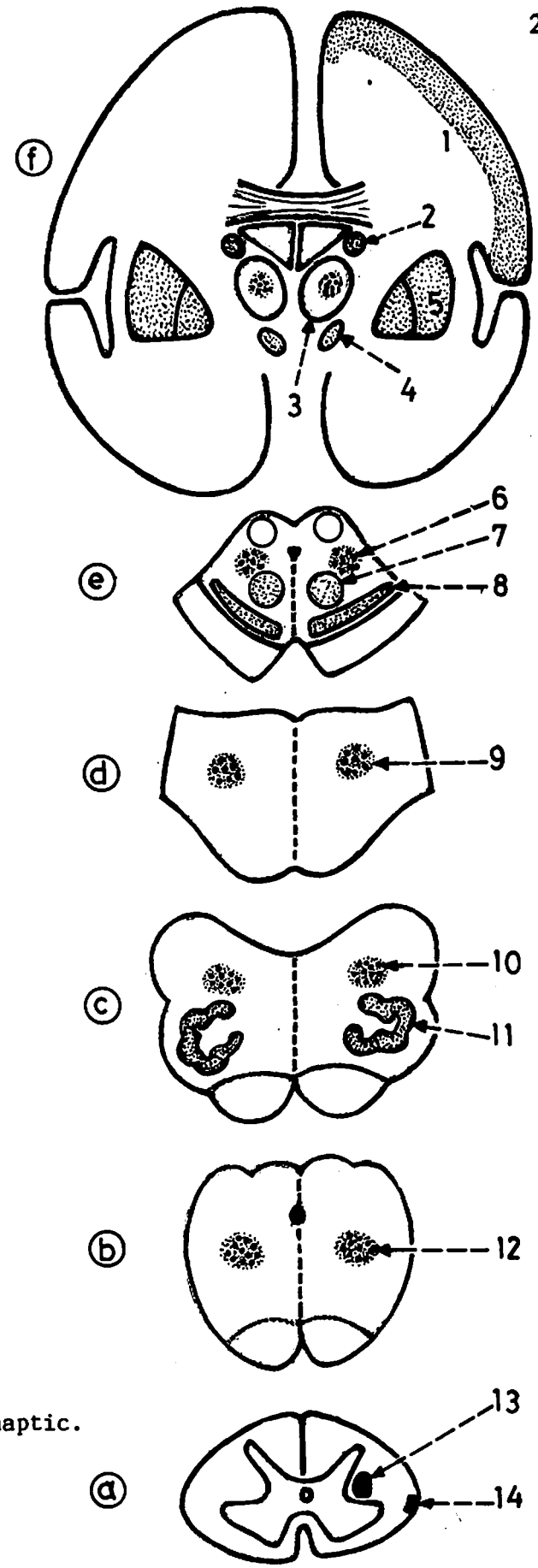
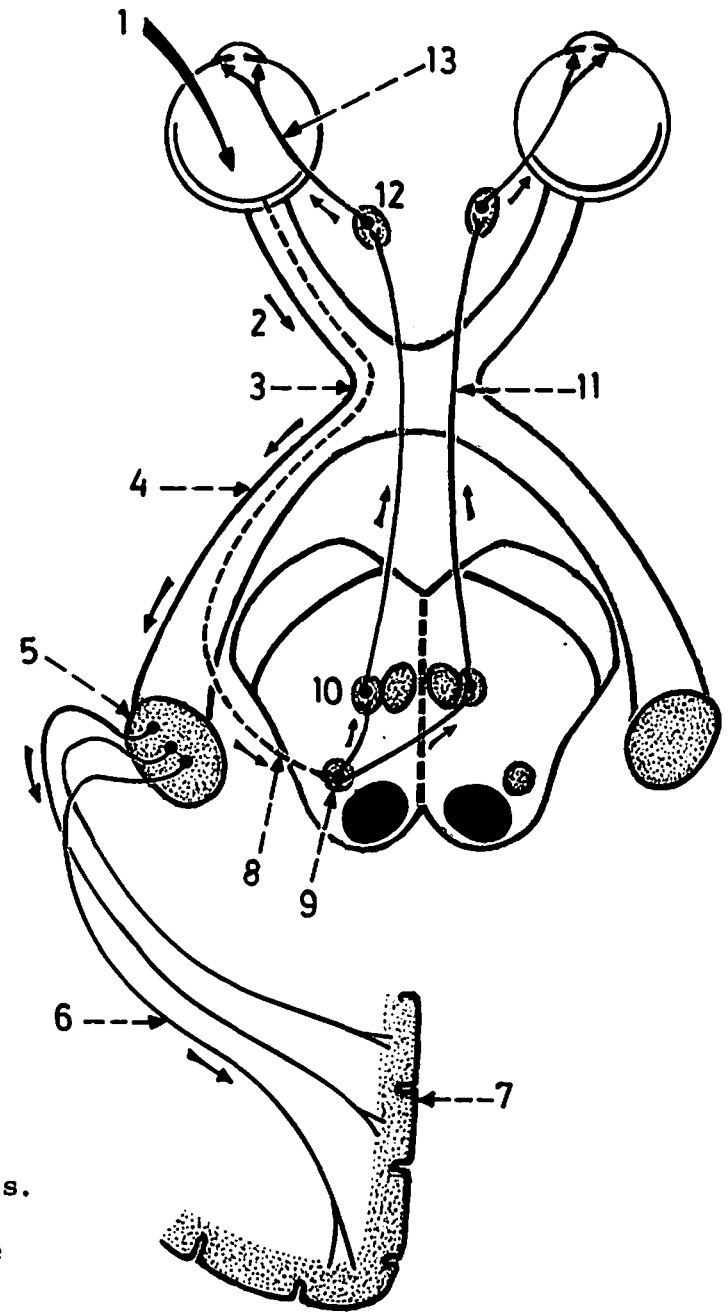


Fig.(396): PATHWAYS OF VISION AND LIGHT REFLEX

The pathway of vision is as follows: retina, optic nerve, optic chiasma, optic tract, lateral geniculate body, optic radiation and occipital cortex. The pathway of light reflex is as follows: retina, optic nerve, optic tract, pretectal nucleus, Edinger-Westphal nuclei of both sides, oculomotor nerves of both sides, ciliary ganglia of both sides and postganglionic fibres to the sphincter pupillae muscle of the iris of both eyes.



1. light falling on the retina.
2. optic nerve.
3. optic chiasma.
4. optic tract.
5. lateral geniculate body.
6. optic radiation.
7. occipital cortex.
8. fibres of light reflex leaving the optic tract.
9. pretectal nucleus.
10. Edinger-Westphal nucleus.
11. oculomotor nerve (preganglionic fibres).
12. ciliary ganglion.
13. postganglionic fibres to the sphincter pupillae muscle of iris.

* In light reflex, exposure of one eye to bright light results in contraction of the pupil of the same as well as of the opposite eye.

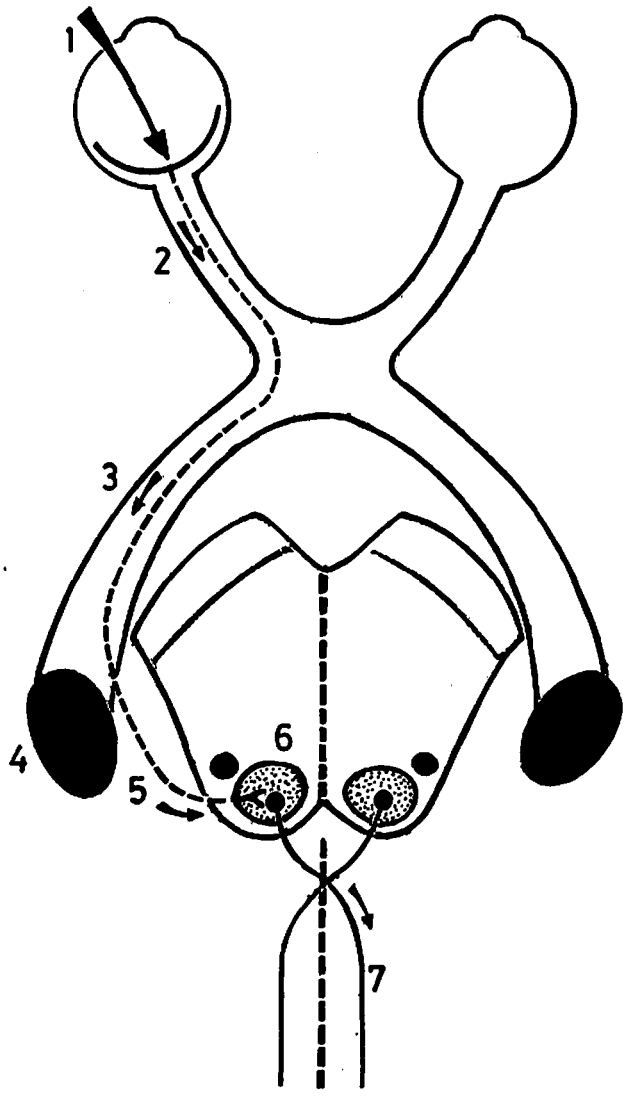


Fig.(397): PATHWAY OF SPINOVISUAL REFLEX

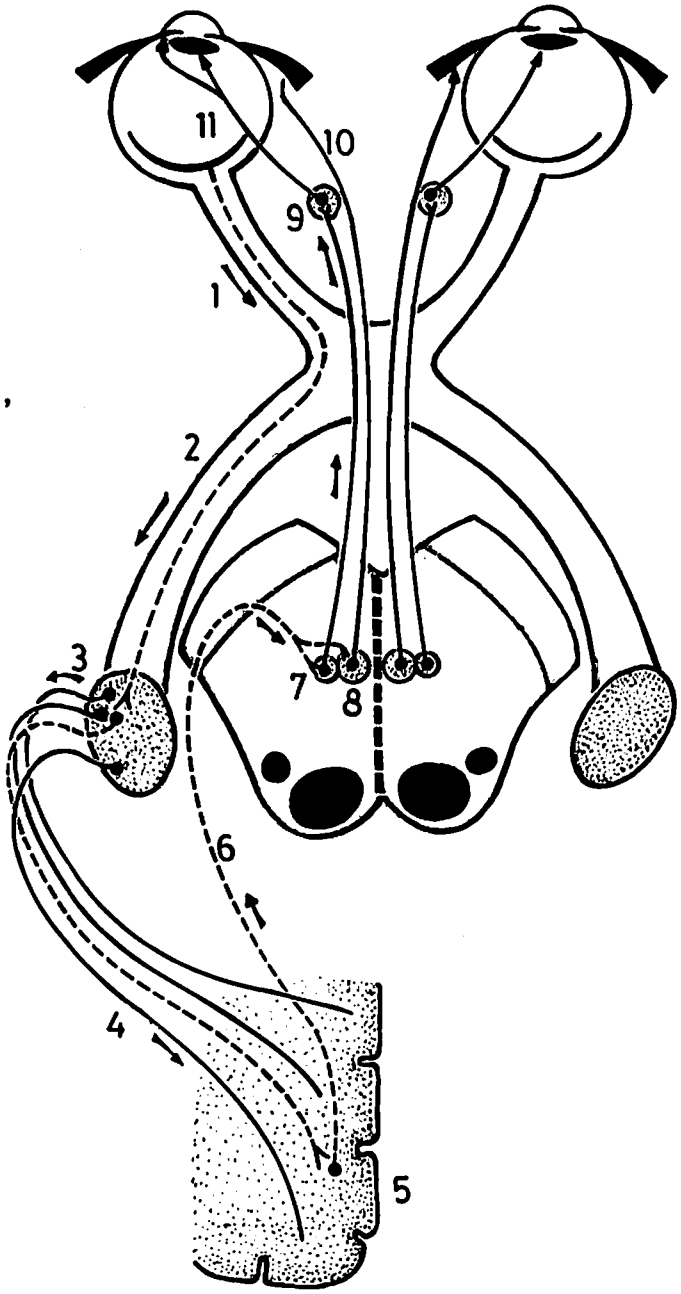
In this reflex, light falling on the retina leads to reflex movements of the eye, head and neck as well as the limbs.
Its pathway is as follows: retina, optic nerve, optic tract, superior colliculus, tectobulbar and tectospinal tracts on the opposite side and then the nuclei of 3rd, 4th and 6th cranial nerves as well as the anterior horn cells of the spinal cord.

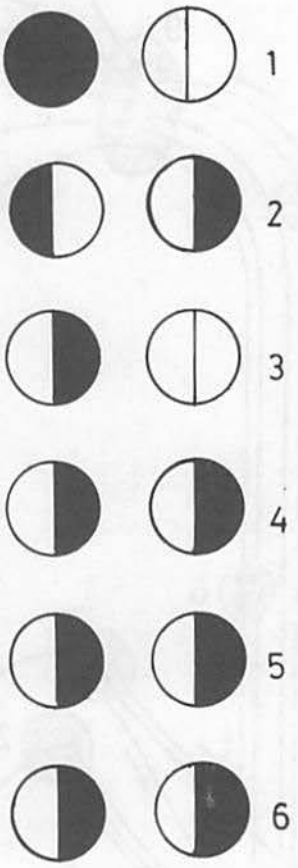
1. light falling on the retina.
2. optic nerve.
3. optic tract.
4. lateral geniculate body.
5. fibres of spinovisual reflex leaving the optic tract.
6. superior colliculus of midbrain.
7. tectobulbar and tectospinal tract.

Fig.(398): ACCOMODATION REFLEX

In accomodation reflex the eyes converge, the ciliary muscle contracts to modify the shape of the lens and the constrictor pupillae muscle of the iris contracts to constrict the pupil. Its pathway is as follows: retina, optic nerve, optic tract, lateral geniculate body, optic radiation and visual area in the occipital cortex. Efferent fibres from the occipital cortex pass to the oculomotor nucleus and then through the oculomotr nerve to the extra- and intra-ocular muscles.

1. optic nerve.
2. optic tract.
3. lateral geniculate body.
4. optic radiation.
5. occipital cortex.
6. efferent fibres to the oculomotor nucleus.
7. Edinger-Westphal nucleus.
8. oculomotor nucleus.
9. ciliary ganglion.
10. fibres of oculomotor nerve to extra-ocular muscles.
11. postganglionic fibres to intra-ocular muscles.





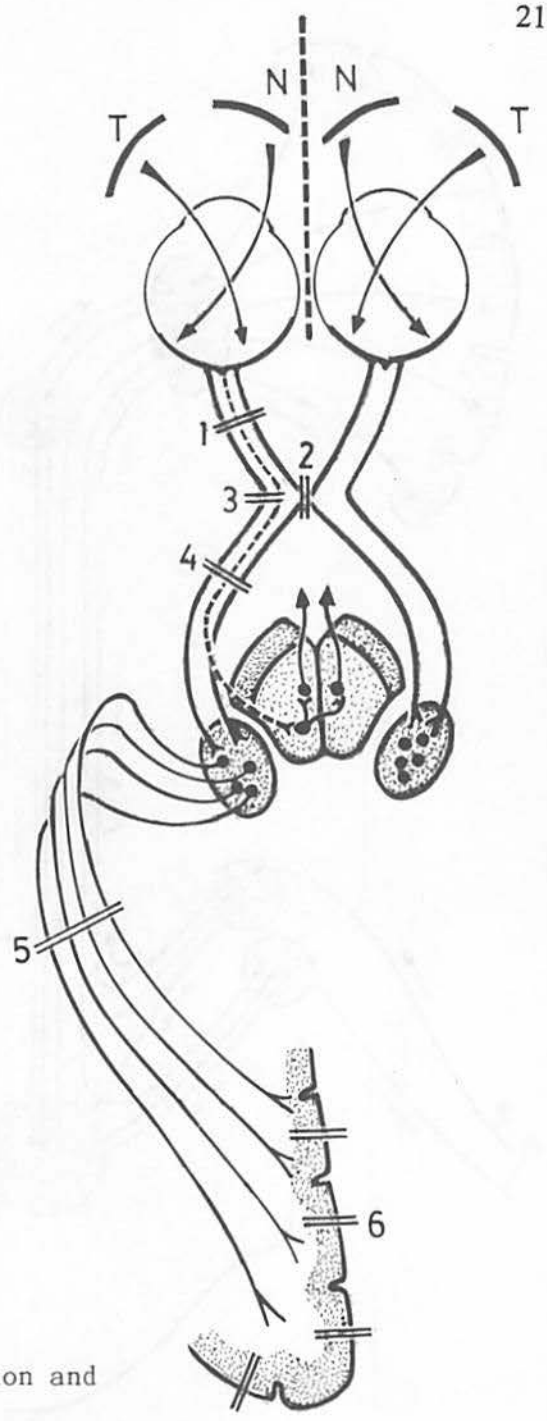


Fig.(399): LESIONS OF VISUAL PATHWAY

1. lesion to optic nerve: complete loss of vision and light reflex on the same side.
2. lesion to the middle of optic chiasma: bitemporal hemianopia.
3. lesion to the lateral part of optic chiasma: ipsilateral nasal hemianopia and loss of light reflex on the same side.
4. lesion to optic tract: contralateral homonymous hemianopia and loss of light reflex.
5. lesion to optic radiation: contralateral homonymous hemianopia without loss of light reflex.
6. lesion to visual area of occipital cortex: contralateral homonymous hemianopia without loss of light reflex.

* Bitemporal hemianopia = loss of temporal fields of vision on both sides.
* contralateral homonymous hemianopia = loss of temporal field of opposite side and nasal field of same side.

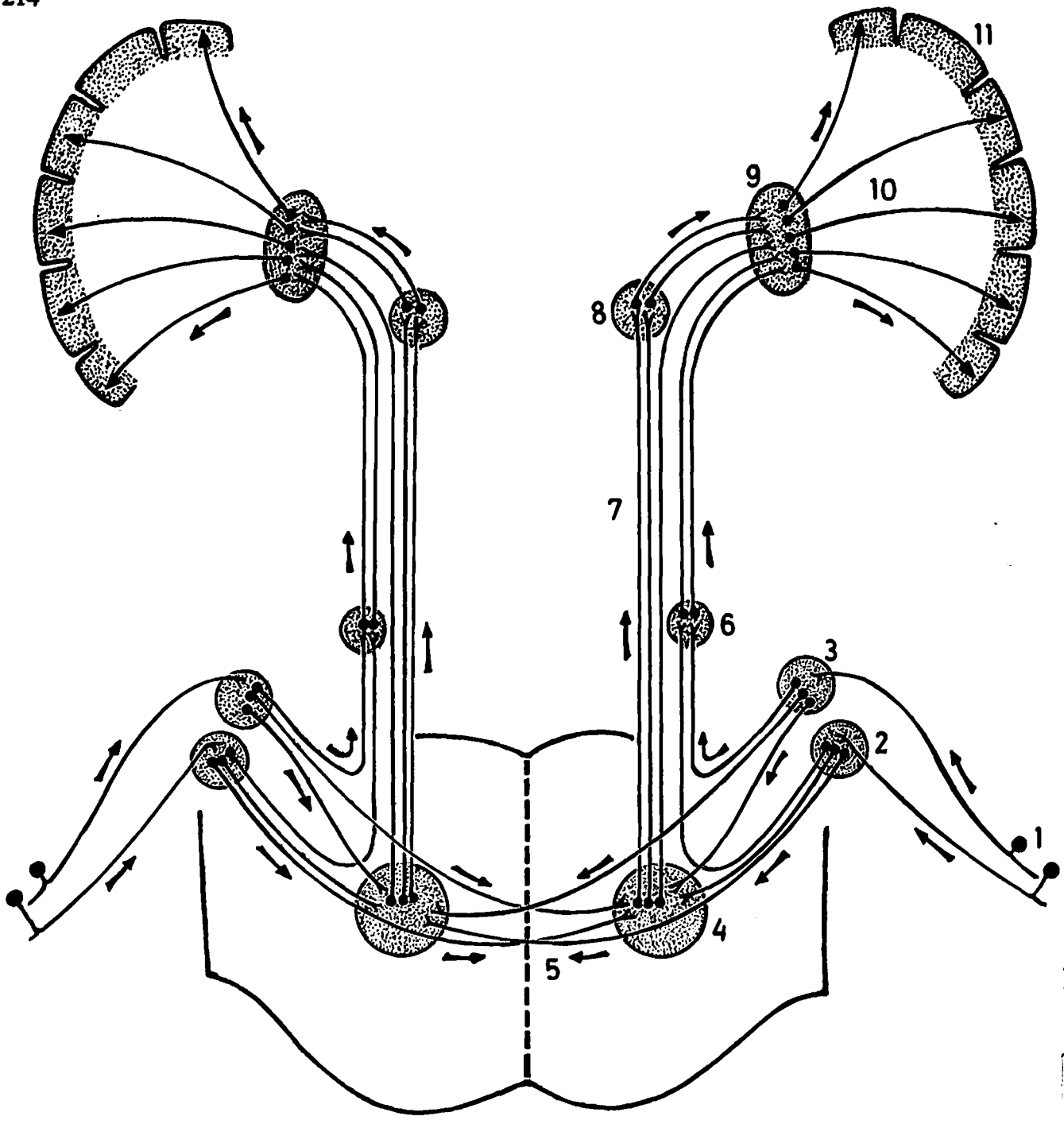


Fig.(400): PATHWAY OF HEARING

1. spiral ganglion in the cochlea.
2. ventral cochlear nucleus.
3. dorsal cochlear nucleus.
4. trapezoid nuclei and superior olivary nucleus.
5. trapezoid body (decussating fibres).
6. nucleus of lateral lemniscus.
7. lateral lemniscus (receives hearing sensation from both sides).
8. inferior colliculus.
9. medial geniculate body.
10. acoustic (auditory) radiation.
11. auditory area(areas 41,42) in the superior and transverse temporal gyri.

Fig.(401): PATHWAY OF SMELL

This pathway is as follows: olfactory nerve, olfactory bulb and tract, primary olfactory cortex and finally secondary olfactory cortex.

1. olfactory bulb (receives the olfactory nerve).
2. olfactory tract.
3. primary olfactory cortex (uncus and anterior perforated substance).
4. 2ry olfactory cortex (anterior part of parahippocampal gyrus).

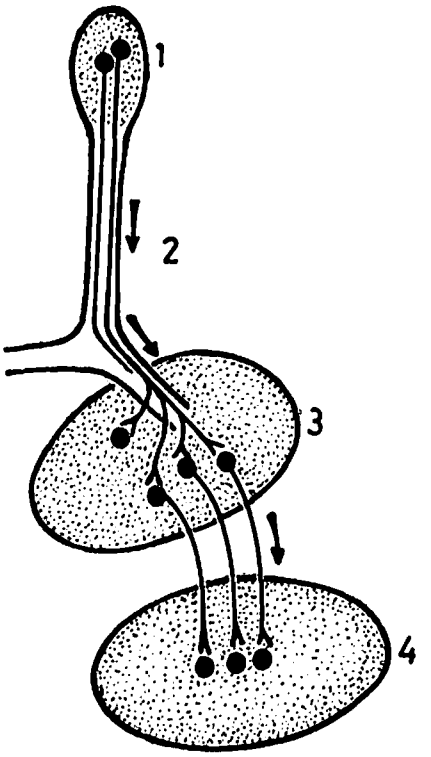


Fig.(402): PATHWAY OF TASTE

Taste is conveyed by the chorda tympani, glossopharyngeal and vagus nerve to the nucleus solitarius, and then ascend on the opposite side to the posteromedial ventral nucleus of thalamus. From the thalamus fibres pass to the gustatory area in the lower part of the postcentral gyrus.

1. nucleus solitarius.
2. tractus solitarius.
3. soft palate.
4. tongue.
5. epiglottis.
6. posteromedial ventral nucleus of thalamus.
7. thalamocortical fibres to the gustatory area.

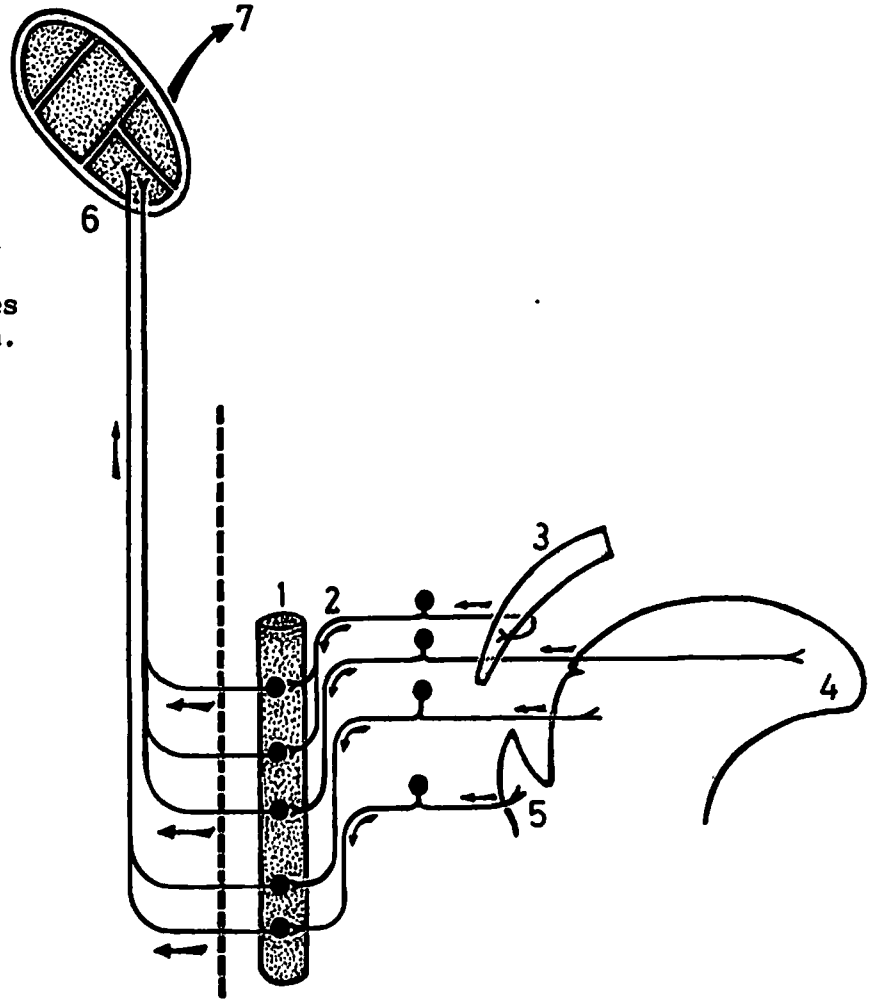
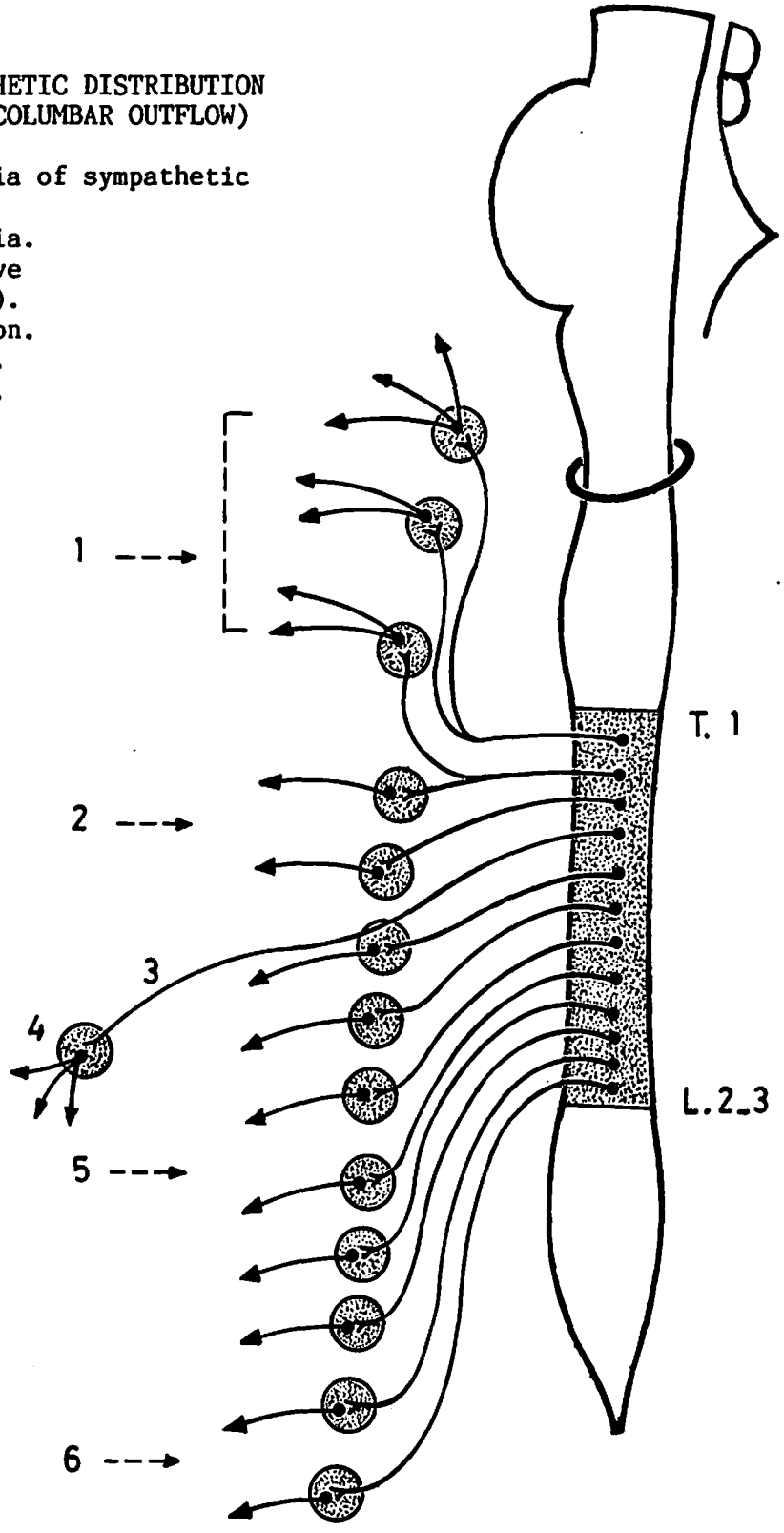


Fig.(403): SYMPATHETIC DISTRIBUTION
(THORACOLUMBAR OUTFLOW)

1. cervical ganglia of sympathetic trunk.
2. thoracic ganglia.
3. splanchnic nerve (preganglionic).
4. coeliac ganglion.
5. lumbar ganglia.
6. sacral ganglia.



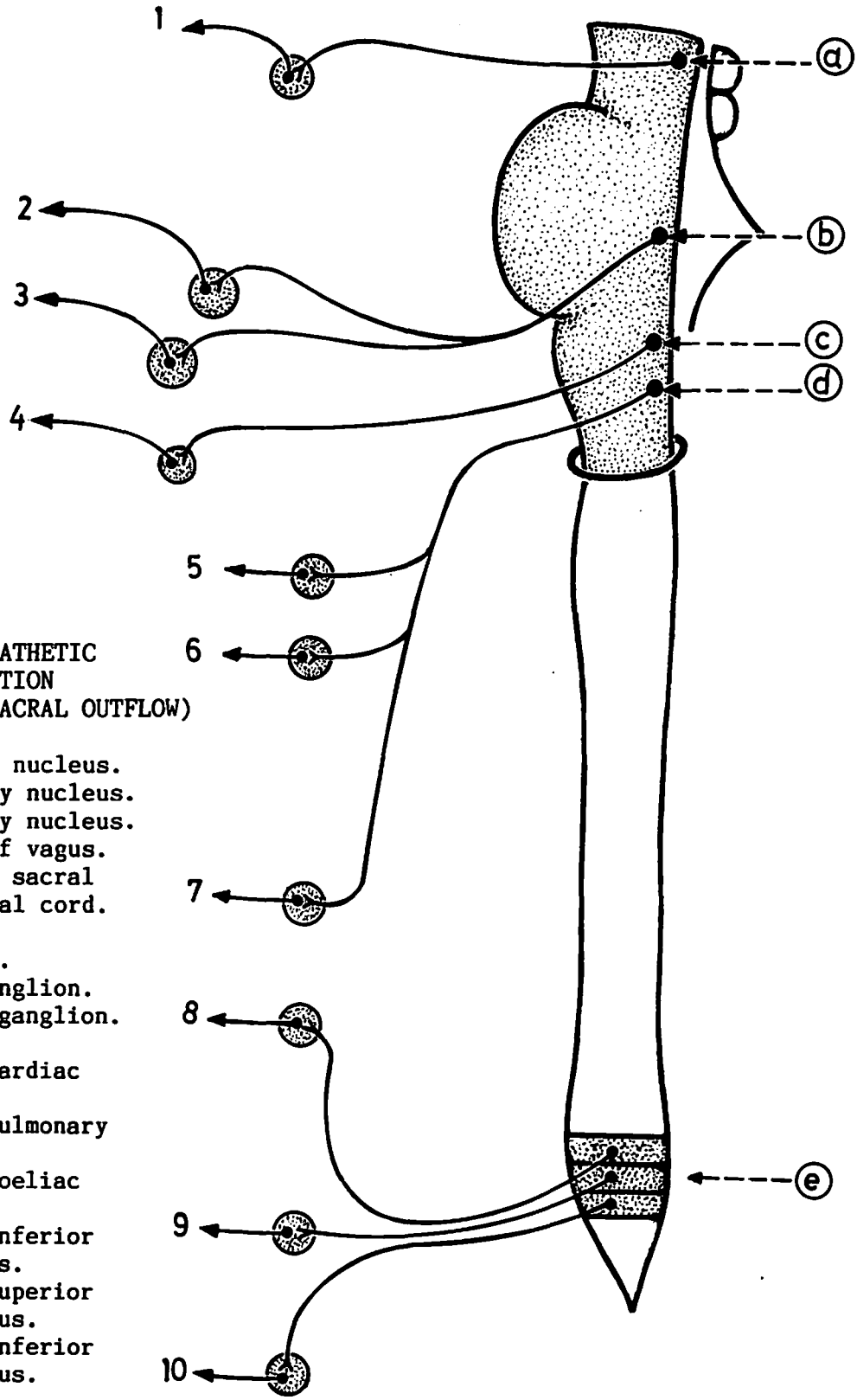


Fig.(404): PARASYMPATHETIC DISTRIBUTION (CRANIOSACRAL OUTFLOW)

a. Edinger-Westphal nucleus.
b. superior salivary nucleus.
c. inferior salivary nucleus.
d. dorsal nucleus of vagus.
e. 2nd, 3rd and 4th sacral segments of spinal cord.

1. ciliary ganglion.
2. submandibular ganglion.
3. pterygopalatine ganglion.
4. otic ganglion.
5. ganglia in the cardiac plexus.
6. ganglia in the pulmonary plexus.
7. ganglia in the coeliac plexus.
8. ganglia in the inferior mesenteric plexus.
9. ganglia in the superior hypogastric plexus.
10. ganglia in the inferior hypogastric plexus.

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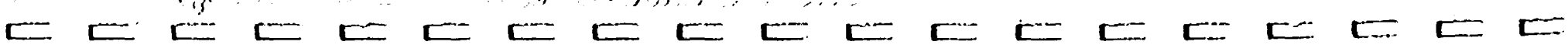

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